Comparative performances of whole-body diffusion-weighted MRI and 18-FDG PET-CT in digestive oncology: preliminary results in a 15-patients study.

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Purpose

Imaging modalities allowing screening of the entire body in a reasonable time with preserved image quality play a major role in oncology.

Integrated 18-FDG PET/CT is still considered as a referring tool in many indications thanks to the functional informations it may provide, combined with good anatomical correlation. The main drawbacks are represented by cost, poor disposibility and ionization.

Whole-body MRI comprising conventional and diffusion-weighted sequences is an emerging and promising technique that is now feasible within an hour on most 1.5 T systems, providing high quality images. The diffusion sequence adds some degree of functionality by indirectly studying the tissue cellularity.

The aim of this study was to compare the performances of those two whole-body imaging techniques in a population of patients with neoplasms of the digestive tract, which are among the most frequent in general oncology.
Methods and Materials

1. Population:

15 patients with digestive neoplasms were addressed by the Digestive Surgery Department of our institution between February and July 2010 for whole-body imaging screening, including MRI and 18-FDG PET/CT. Patients consent was obtained.

Inclusion criteria were pretherapeutic statements and suspected relapse assessments.

Exclusion criteria were represented by contra-indications for either modality (pace-maker, metallic implants, claustrophobia, imbalanced diabetes, pregnancy) and administration of specific anti-cancer treatment between both examinations.

The delay between MRI and PET/CT did not exceed 12 days.

All neoplasms were adenocarcinoma, with several localizations: cardia (n=2), duodenum (n=1), pancreas (n=2), colon (n=6) and rectum (n=4).

2. Imaging technique and interpretation:

• Whole body MRI:

All examinations were made on a standard 1.5 T system using table coil and multiple phased-array coils. Exploration extended from the vertex to the upper thighs and was performed within an hour. Our protocol was the following:

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Imaging plane</th>
<th>Slice thickness</th>
<th>Steps</th>
<th>Acquisition time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffusion WB</td>
<td>axial</td>
<td>7 mm</td>
<td>4 to 5</td>
<td>26 min 17 s</td>
</tr>
<tr>
<td>(b50-b800)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STIR WB</td>
<td>coronal</td>
<td>5 mm</td>
<td>3 to 4</td>
<td>8 min</td>
</tr>
<tr>
<td>TSE T1 WB</td>
<td>coronal</td>
<td>5 mm</td>
<td>3 to 4</td>
<td>8 min 12 s</td>
</tr>
<tr>
<td>3D T1 Gd liver</td>
<td>axial</td>
<td>5 mm</td>
<td>1</td>
<td>24 s</td>
</tr>
<tr>
<td>3D T1 Gd WB</td>
<td>coronal</td>
<td>5 mm</td>
<td>3 to 4</td>
<td>1 min 59</td>
</tr>
</tbody>
</table>

(WB=Whole Body; TSE=Turbo Spin Echo; Gd=Gadolinium)
All examinations were interpreted blindly to the PET/CT results by the same senior radiologist.

Native diffusion images were read in normal and inverted gray scale and correlated with the signal on ADC map (Figure 1 on page 6). Conventional sequences were read on both native and whole-body fused images (Figure 2 on page 6).

Pathologic lesions were referenced as follow:

- pulmonary nodules visible on all sequences, showing restriction of diffusion, that is high signal on b800 sequences and relatively low signal on ADC map.
- nodes > 10 mm in size showing restricted diffusion
- visceral lesions showing high signal on STIR sequence, restricted diffusion and evocative gadolinium enhancement
- osseous lesions showing high signal on STIR, low signal on T1 sequence and restricted diffusion.

• 18-FDG PET/CT imaging

All examinations were performed on an integrated 4 detectors system. Similarly, exploration extended from the vertex to the upper thighs and was performed at least 60 minutes after intravenous administration of 18-FDG.

CT scan was used to determine attenuation coefficients and as an anatomical correlation tool.

All examinations were interpreted blindly to the MRI results by the same senior nuclear medicine physician.

Native images, fused images and 3D MIP (Figure 3 on page 7) reconstructions were read on a dedicated software.

Any lesion > 5 mm in size showing increased, pathologic FDG uptake was considered malignant.

3. Statistical analysis:
Student's "t" test and Pearson's correlation coefficient were used to appreciate differences between depicted suspicious lesions number, station by station. A $p$-value inferior to 0.05 was considered significant.

Sensitivity and specificity per patient were calculated for each imaging technique.

Only the sensitivity per lesion could be appreciated given the absence of any false negative lesion in this study.

Standards of reference included histological proof, radiological history, clinical and radiological follow-up, and radiological probability, which means any lesion with typical patterns on MRI and PET-CT in a multi-metastatic patient was considered malignant.
Fig. 0: b50 (top left) and b800 (top right) diffusion abdominal images on a healthy subject. b800 inverted gray scale image (bottom left) and corresponding ADC map (bottom right).

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Fig. 0: coronal fused MRI images on T1 TSE (left), STIR (middle) and 3D T1 gadolinium-enhanced (right) sequences, same patient as above.

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**Fig. 0:** native PET image (top left), axial (bottom left) and coronal (middle) fused PET/CT images and 3D MIP reconstruction (right), same patient as above.

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Results

1. Overall performances:

<table>
<thead>
<tr>
<th></th>
<th>MRI</th>
<th>PET/CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of depicted lesions</td>
<td>86</td>
<td>89</td>
</tr>
<tr>
<td>Per-patient sensitivity</td>
<td>86%</td>
<td>92%</td>
</tr>
<tr>
<td>Per-patient specificity</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Per-lesion sensitivity</td>
<td>92%</td>
<td>82%</td>
</tr>
</tbody>
</table>

Performances were good for each technique.

The excellent per-patient specificity value is due to the fact that one patient with suspected recurrence of a cardial cancer was considered true negative. Indeed, no lesion was found either on MRI or PET/CT, and clinical and radiological follow-up was normal at 6 months.

2. Detailed results:

- **Head and neck:**

  No suspicious lesion was detected on those stations, especially neither cerebral metastases nor cervical adenopathies.

- **Pulmonary nodules:**

  More nodules were depicted on PET/CT. This is likely due to the higher spatial resolution of this technique, as most of the lesions were <10 mm in this study.

  2 mediastinal adenopathies were missed on MRI, probably because of motion artifacts.

- **Liver lesions:**
In our study, MRI was slightly more efficient in the detection of liver metastases: in 2 patients, lesions that were clearly visible on MRI were missed on PET/CT (on page 11 Figure 1 on page 11).

- **Bone metastases:**

  Both techniques were equally performant for the detection of osseous lesions (Figure 2 on page 11).

- **Other lesions:**

  MRI and PET/CT both managed to depict local recurrence of a pancreatic cancer (on page 12 Figure 3 on page 12) and a rectal cancer.

  Abdominal and pelvic adenopathies, peritoneal carcinosis nodules (Figure 4 on page 13) were also perfectly shown by those two modalities.
Images for this section:

**Fig. 0:** liver recurrence of a pancreatic adenocarcinoma, with 2 metastases depicted on MRI (bottom, b800 diffusion image) that were missed on PET/CT (top, axial fused image).

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**Fig. 0:** osseous metastasis of the sacrum (white arrows) in a patient with multimetastatic rectal adenocarcinoma, well seen on MRI (left, coronal STIR image) and PET/CT (right, coronal fused image). Note another lesion on T11 vertebra and associated liver nodules.

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Fig. 0: pelvic recurrence of a rectal cancer (white arrow) on PET/CT (top, axial fused image) and MRI (bottom, axial b800 diffusion image).

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Fig. 0: peritoneal carcinosis (white arrow) on PET/CT (top, axial fused image) and MRI (bottom, axial b800 diffusion image)

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Conclusion

Our results shows that whole-body MRI using conventionnal and diffusion sequences and 18-FDG PET/CT are two reliable screening techniques in patients with digestive neoplasms.

Litterature data show similar results as regards melanoma, breast and pulmonary cancers in studies comparing these two whole-body imaging modalities.

In our study, conducted in a limited population of 15 patients, MRI was slightly more efficient for the detection of liver lesions, whereas PET/CT depicted more pulmonary nodules.

Whole-body diffusion MRI is now feasible on most 1.5 T systems and may represent an alternative in places where PET/CT is not available.
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