The role of FUSION between MRI and PET-CT as preoperative staging in breast cancer

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Pamplona, Spain
• The authors have nothing to disclose

• This study was approved by the ethic committee at our institution
**INTRODUCTION**

**Staging of breast cancer**

- To assess the tumoral size
- To analyze the presence of multifocal, multicentric and contralateral lesions
- To evaluate axillary lymph nodes
Staging of breast cancer

TECHNIQUES

MORPHOLOGICAL
- Mammography
- US

FUNCTIONAL
- CE-MRI
- 18F-FDG PET/CT
• **CE-MRI:**
  - Based on **neoangiogenesis**
  - High Sensitivity (95-98%)
  - Low/intermediate Specificity (40-95%)

• **18F-FDG PET/CT:**
  - Based on **glicidic metabolism**
  - Intermediate Sensitivity
  - Intermediate/high Specificity
  - Complete extension of the disease
INTRODUCTION

SAME PATIENT

(Images from different techniques are hardly comparable if the patient position is different)
Recently a new software has been developed that allows the FUSION of images acquired by both techniques (TRUED, Siemens, Germany).
To compare the **sensitivity (SE)** and **specificity (SP)** of preoperative **MRI**, **PET-CT** and **FUSION** images between both techniques.
From November 2011 to August 2013, 31 consecutive patients with histologically proven breast cancer were included. All of them underwent both preoperative MRI and PET-CT.

Inclusion criteria:

18F-FDG PET/CT

(Biograph mCT64, True V, Siemens)

CE-MRI

(1.5T AERA, Siemens, Erlangen, Germany)

MATERIALS AND METHODS
Inclusion criteria

**MATERIALS AND METHODS**

**RETROSPECTIVE STUDY**

67 Breast lesions

- 31
- 40 BREAST CANCER (histologically proven)
- 27 BENIGN lesions (biopsy and/or follow-up)
The **FUSION technique** is based on two main facts:

1) Both **CE-MRI** and **18F-FDG PET/CT** are acquired with the patient in **PRONE POSITION**, using the **same MRI breast array coil**

A 4 channel breast MRI coil is used in both techniques (Noras, Höchberg, Germany)
### CE-MRI

*(1.5T Aera, Siemens, Erlangen, Germany)*

- STIR (TR=5000 ms, TE=57.0 ms, TI=170 MS Flip angle=141°, Voxel=1.1x1.1x4 mm)
- FLASH 3D (TR=4.82 ms, TE=1.85 ms, Flip angle=10°, Fat-Sat, Voxel=0.8x0.8x1.5 mm)
- Injection of 0.1 mmol/kg of paramagnetic contrast (Gadovist, Bayer)
- Dynamic T1w post-contrast study (5 acquisitions at a time resolution of 60s)
- Subtraction images are obtained

### 18F-FDG PET/CT

*(Biograph mCT64, True V, Siemens)*

- 60 min after administration of 0.12 mCi / kg of 18F-FDG. We acquire two series:

1) **In SUPINE position 6 beds whole body acquisition**: used for the complete study of the extension of the disease

2) **In PRONE position 2 beds acquisition using the breast array coil**: focused in both breasts and underarms
MATERIALS AND METHOD

Both techniques with the same patient in PRONE POSITION

CE-MRI + 18F-FDG PET/CT = FUSION IMAGES
The **FUSION technique** is based on two main facts:

2) A dedicated software (*TRUED, Siemens, Germany*) in a workstation (*Leonardo, Siemens, Germany*) is needed to perform the **FUSION** of both images.
– **CE-MRI images** were evaluated by an **expert breast radiologist** with more than ten years of experience, blinded to the final diagnosis

– **18F-FDG PET/CT images** were evaluated by an **expert nuclear medicine doctor**, blinded to the final diagnosis

– **FUSION images** were evaluated **RETROSPECTIVELY** by consensus of: two expert breast radiologists and two nuclear medicine doctors
MATERIALS AND METHOD

Analysis

– The correlation of images between MRI and PET/CT was evaluated and classified by consensus in:
  • *EXCELLENT*: full coincidence
  • *ACCEPTABLE*: <10 mm displacement
  • *POOR*: ≥10 mm displacement

– All lesions were classified as positive (malignant) or negative (benign) for each technique and compared with the *gold standard (surgery or follow-up)*
  • **CE-MRI**: BI-RADS 3, 4 and 5 were considered malignant (positive)
  • **PET/CT**: morphological and visual criteria were used to classify benign/malignant. The SUV value was not considered
– Statistical differences in SE and SP of the different imaging techniques were calculated using PEPI software (4.04 JH Abramson & PM Gahlinger)
Main characteristics of women and tumours

Mean age: 52.6 years old (35-81)
### RESULTS

**A. Descriptive**

**Quality evaluation of fusion images**

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<thead>
<tr>
<th>EXCELLENT</th>
<th>ACCEPTABLE</th>
<th>POOR</th>
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<tbody>
<tr>
<td><em>Full coincidence</em></td>
<td><em>&lt; 10 mm displacement</em></td>
<td><em>≥ 10 mm displacement</em></td>
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<tr>
<td>12 women (39 %)</td>
<td>16 women (52 %)</td>
<td>3 women (9 %)</td>
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Table 1. Evaluation of sensitivity and specificity of each technique

<table>
<thead>
<tr>
<th>Method</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
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<tbody>
<tr>
<td>CE-MRI</td>
<td>97.5</td>
<td>11.1</td>
</tr>
<tr>
<td>18F-FDG PET/CT</td>
<td>92.5</td>
<td>85.2</td>
</tr>
<tr>
<td>FUSION</td>
<td>95</td>
<td>96.3</td>
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</table>
### Table 2. Comparison of SE and SP between CE-MRI and FUSION

<table>
<thead>
<tr>
<th></th>
<th>CE-MRI</th>
<th>FUSION</th>
<th></th>
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<tbody>
<tr>
<td>SENSITIVITY (%)</td>
<td>97.5</td>
<td>95</td>
<td>ns</td>
</tr>
<tr>
<td>SPECIFICITY (%)</td>
<td>11.1</td>
<td>96.3</td>
<td><em>p</em> &lt; 0.05</td>
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### Table 3. Comparison of SE and SP between PET/CT and FUSION

<table>
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<tr>
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<th>PET/CT</th>
<th>FUSION</th>
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<td>SENSITIVITY (%)</td>
<td>92.5</td>
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<td>85.2</td>
<td>96.3</td>
<td>ns</td>
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</table>
CE-MRI

18F-FDG PET/CT

FUSION IMAGES
45 y/o woman with BI-RADS 5 lesion in the right breast: IDC

**Case 1**

Extensive mass enhancement was seen in the right breast, highly suspicious of breast cancer.

Heterogeneous 18F-FDG uptake in the right breast was seen, suspicious of malignancy.
FUSION images confirmed the suspicion of breast malignancy. In this case, the FUSION between the images was excellent.
- **18F-FDG PET/CT** detected suspicious hepatic lesions (black arrow) 
  Biopsy: breast cancer metastases
Case 2

51 y/o woman with BI-RADS 5 lesion in the right breast: IDC

**FUSION images** confirmed the suspicion of breast malignancy

In this case the **FUSION** between the images was excellent
- **18F-FDG PET/CT** showed two suspicious deposits in the contralateral breast.
- On **FUSION images**, those foci of 18F-FDG uptake were matched with two areas of rim enhancement.
- These uptakes were in relation with inflammatory changes surrounding cysts, clearly diagnosed on **CE-MRI** as benign process and confirmed by fine needle aspiration (**false positive** of **18F-FDG PET/CT**).
60 y/o woman with BI-RADS 5 lesion in the left breast: IDC

- **18F-FDG PET/CT** showed an heterogeneous 18F-FDG uptake
- **CE-MRI** detected an extensive non-mass enhancement, highly suspicious
- **FUSION images** confirmed the concern of breast malignancy. **FUSION** between both images was poor (> 10 mm displacement). Nevertheless the interpretation was quite easy
- **18F-FDG PET/CT** did not inform any additional suspicious uptakes
- **CE-MRI** detected an additional, non-mass enhancement located in the upper external quadrant of the same breast, suspicious of malignancy (white arrow).
- **FUSION** images showed a subtle deposit on the non-mass enhancement (red arrow).
- Biopsy: multicentric IDC (false negative of **18F-FDG PET/CT**)
In this particular case **FUSION images** were useful to evaluate an additional suspicious lesion detected by **CE-MRI** (white arrow) as negative-benign lesion (green arrow). **False positive** of **CE-MRI**
LIMITATIONS

- Retrospective
- Small number of cases
- Probably benign lesions (BIRADS-3) were considered positive on CE-MRI
CONCLUSIONS

1. The **FUSION** of images between **CE-MRI** and **18F-FDG PET/CT** is a feasible technique.

2. The **FUSION** of images increases significantly the **SPECIFICITY** of preoperative **CE-MRI** (SP: 11.1% vs 96.3%; p<0.05) without decreasing the sensitivity (SE: 97.5% vs 95%; ns).