Preliminary experiences of DBT (Digital Breast Tomosynthesis) and hybrid 18F-FDG-PETMR for neoadjuvant chemotherapy (NAC) cases in breast cancer

Poster No.: C-0582
Congress: ECR 2018
Type: Scientific Exhibit
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Keywords: Pathology, Image verification, Image registration, Diagnostic procedure, Computer Applications-General, Chemotherapy, PET-MR, Image manipulation / Reconstruction, Digital radiography, Oncology, Management, Breast
DOI: 10.1594/ecr2018/C-0582

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Aims and objectives

To verify clinical findings of new diagnostic modalities of DBT and 18F-FDG-PETMR for evaluations of loco-regional staging and treatment response of NAC in comparison with pathological findings.
Methods and materials

In this study, primary 16 patients with 17 invasive breast cancers (IDC: =15, ILC: n=1, and Metaplastic Ca: n=1), that NAC was preoperatively underwent, were enrolled. The average age was 48±12.25 y.o.. Clinical stage was cT2-4 N0 (IIA: n=3) or cT1-4 N1-3 (IIA: n=1, IIB: n=6, and IIIC: n=6). 2DMMG+DBT, US, and PET/MRI were obtained before and after NAC. As whole-body scans, a hybrid system of PET and 3.0T MR was obtained after intravenous injection of $^{18}$F-FDG followed by a resting period of 60 min in a supine position as early phase and T1WI and T2WI without fat suppression of MR images were obtained. In addition, breast MR images were conducted with a dedicated bilateral 8-channel breast radiofrequency coil in a prone position. As well as breast MR, breast PET images as late phase 80 min after injection were obtained in a prone position. MR imaging protocol were consisted of T2WI with fat suppression, DWI, and a four phases of dynamic contrast enhanced T1WI sequences (30, 90,180, and 270 seconds) with fat suppression were obtained. The breast PET and MR images were evaluated independently and the fusion images of early phase (90 seconds) of dynamic contrast enhanced T1WI and the PET images at late phase were also evaluated.

For determining cN-stage, numb and location of suspicious lymph nodes were assessed on MRI and FDG uptake. Pathological diagnosis of primary lesion and LNs were confirmed by US-guided biopsy before NAC. NAC response was evaluated the primary lesion as increased FDG uptake compared to the surrounding breast tissue by PET and the enhanced area by MRI. Regarding DBT, the images were acquired by MLO and CC views with the rotation angle of ±25°and reconstructed into 2 mm thick slices having 1mm overlap with high in-plane resolution of 0.085 mm × 0.085 mm. NAC response was evaluated by the diameter and the residual density of the lesion. The clinical response to chemotherapy was classified into the following categories, based on the "response evaluation criteria in solid tumors" (RECIST) and pathological response to NAC was classified in accordance with the criteria by Japanese Breast Cancer Society (JBCS) (Table 1).
Histological criteria for assessment of therapeutic response in breast cancer in accordance with JBCS (Japanese Breast Cancer Society)

Grade 0: (no response) Almost no change in invasive cancer cells after treatment
Grade 1: (slight response)
1a: (mild response): Mild changes in invasive cancer cells regardless of the area, or marked changes are seen in less than one-third of cancer cells
1b: (moderate response) Marked changes in one-thirds or more of invasive cancer cells
Grade 2: (marked response)
2a: (marked response) Marked changes in two-thirds or more of invasive cancer cells
2b: (extremely marked response)
Less than a few clusters of invasive cancer cells remaining
Grade 3: (complete response) Necrosis or disappearance of all invasive cancer cells; replacement of all cancer cells by granuloma-like and/or fibrous tissue

The clinical response to chemotherapy was classified into the following categories, based on the "response evaluation criteria in solid tumors" (RECIST)

   2)Partial Response (PR): reduction in size of the tumor by more than 30%
2. Non-Responders: 1) a: Stable disease (SD): reduction in size of the tumor by less than 30%
   2) Progressive disease (PD): increase in size of tumor or presence of new lesions.

Table 1: Histological criteria for assessment of therapeutic response in breast cancer in accordance with JBCS

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Results

Before NAC, PETMR detected primary lesions and LN metastasis as enhanced and enlarged lesions with MR and FDG uptake with PET by 100%. The mean±SD of SUV of the primary lesion and LN were 9.95±5.90 and 8.52±5.95. Pathological responses of the lesions to NAC were Grade 0 (n=1), Grade 1a (n=2), Grade 1B (n=4), Grade 2 (n=5), and Grade 3 (n=5).

Among the cases of pathological Grade 3 (n=5), 2D+DBT demonstrated the lesions as no residual mass lesion with or without microcalcifications as CR (4/5:80.0%) or reduced mass with or without microcalcifications as PR (1/5:20%). Shrinkage pattern of the lesion was concentric pattern with 2D+DBT. PETMRI demonstrated the lesions as reduced enhanced mass lesion by MRI as PR (n=3) and no residual mass lesion (n=2) as CR. FDG uptake was positive before NAC and negative after NAC in all of the cases. Regarding the Grades 1b-2 lesions (n=9), 7 lesions were detected as reduced masses with or without microcalcifications as PR (7/9: 77.8%). Shrinkage pattern of the lesion were concentric pattern (4/7: 57.1%) and honeycomb pattern (3/7:42.9%). Two lesions were detected as no residual mass lesion with or without microcalcificatons as CR (2/9: 22.2%) by 2D+DBT. PETMRI demonstrated the lesions as reduced enhanced mass lesion by MRI as PR (8/9:88.9%) and no residual mass lesion (1/9: 11.1%) as CR. After NAC, FDG uptake was positive in 3 lesions (3/9: 33.3%) and negative in 6 lesions (6/9: 66.7%) . Regarding the Grade 0-1a cases (n=3), the lesions were detected as a slightly enlarged mass (n=1) or slightly reduced mass (n=1) that suggested SD (2/3: 66.7%) and as a reduced mass (n=1) that suggested PR (1/3: 33.3%) with 2D+DBT and PETMR. Shrinkage pattern of the lesion were concentric pattern (2/3: 66.7%) and honeycomb pattern (1/3:33.3%) with 2D+DBT. After NAC, FDG uptake was positive in 2 lesions (66.7%) and negative in 1 lesions (33.3%) (Table 2, Fig.3-5).
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Table 1: Histological criteria for assessment of therapeutic response in breast cancer in accordance with JBCS

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<table>
<thead>
<tr>
<th>No. of Lesions</th>
<th>age</th>
<th>T N M</th>
<th>stage</th>
<th>Path</th>
<th>Hormonal Subtype</th>
<th>Pre NAC LN metastasis</th>
<th>Pathological Response</th>
<th>Clinical Response with PETMR by RECIST</th>
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Table 2: Staging of the Lesions and Results of NAC Response with DBT and PETMR in Accordance with RECIST and Pathological Response

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Fig. 1: No.13 Grade 3

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Fig. 2: No.11. Grade2a

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Fig. 3: No.5 & 6. Grade 1b & 1b

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Conclusion

Prior to NAC, PETMRI shows promising results for loco-regional staging. In addition, post NAC, combined usage of 2D+DBT and PETMRI can predict more accurate treatment response.
References


