PET/CT TIL KNOGLEMETASTASER
FDG OG/ELLER NAF?
DISSEMINATION OF BREAST CANCER

Recurrence
• 25 – 35 %

Bone metastases
• 50 – 70 %

Skeletal related events
• Survival

BREAST CANCER METASTASES AND RECURRENCE

Primary breast cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up

Breast Cancer Follow-Up and Management After Primary Treatment: American Society of Clinical Oncology Clinical Practice Guideline Update
## DIAGNOSIS OF DISTANT METASTASIS

<table>
<thead>
<tr>
<th>Modality</th>
<th>Sensitivity / % (95% CI)</th>
<th>Specificity / % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDG-PET/CT</td>
<td>96 (90-98)</td>
<td>95 (92-97)</td>
</tr>
<tr>
<td>Conventional imaging</td>
<td>56 (38-74)</td>
<td>91 (78-97)</td>
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## DIAGNOSIS OF DISTANT METASTASIS

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<tbody>
<tr>
<td>FDG-PET/CT</td>
<td>99 (88-100)</td>
<td>95 (89-98)</td>
</tr>
<tr>
<td>Conventional imaging</td>
<td>57 (37-74)</td>
<td>88 (78-94)</td>
</tr>
</tbody>
</table>

The forest plot of sensitivity and specificity for 18FDG PET-CT in the detection of bone metastases in breast cancer patients.

The forest plot of sensitivity and specificity for bone scintigraphy in the detection of bone metastases in breast cancer patients.

## DIAGNOSIS OF BONE METASTASES

<table>
<thead>
<tr>
<th>Modality</th>
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</thead>
<tbody>
<tr>
<td>FDG-PET/CT</td>
<td>93 (82-98)</td>
<td>99 (95-100)</td>
</tr>
<tr>
<td>Bone scintigraphy</td>
<td>81 (58-93)</td>
<td>96 (76-100)</td>
</tr>
</tbody>
</table>

DIAGNOSIS OF BONE METASTASES IN BREAST CANCER

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<tbody>
<tr>
<td>FDG-PET/CT</td>
<td>83 (78-91)</td>
<td>95 (89-98)</td>
</tr>
<tr>
<td>Bone scintigraphy</td>
<td>87 (82-91)</td>
<td>88 (85-91)</td>
</tr>
<tr>
<td>MRI</td>
<td>97 (90-100)</td>
<td>97 (90-100)</td>
</tr>
</tbody>
</table>

DIAGNOSIS OF BONE METASTASES

Table 3. According to MRI scan field of view following table show per patient-based sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of WB, SPECT, SPECT/IdCT and SPECT/cdCT compared to MRI in diagnosing bone metastases (value with a 95% confidence interval).

<table>
<thead>
<tr>
<th></th>
<th>WBS</th>
<th>SPECT</th>
<th>SPECT/IdCT</th>
<th>SPECT/cdCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity (%)</td>
<td>87 (72–96)</td>
<td>87 (72–96)</td>
<td>79 (63–90)</td>
<td>84 (69–94)</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>63 (45–79)</td>
<td>71 (54–85)</td>
<td>63 (45–79)</td>
<td>83 (66–93)</td>
</tr>
<tr>
<td>PPV (%)</td>
<td>72 (67–84)</td>
<td>77 (61–88)</td>
<td>70 (54–83)</td>
<td>84 (69–94)</td>
</tr>
<tr>
<td>NPV (%)</td>
<td>81 (62–94)</td>
<td>83 (65–94)</td>
<td>73 (54–88)</td>
<td>83 (66–93)</td>
</tr>
<tr>
<td>Diag. accuracy</td>
<td>75 (64–100)</td>
<td>79 (68–100)</td>
<td>71 (59–100)</td>
<td>84 (73–100)</td>
</tr>
</tbody>
</table>

CT skanning af thorax og abdomen (kan erstattes af røntgen af thorax og UL af abdomen)

Knogleskintigrafi

Ved abnorme foci bør der gennemføres enten røntgen, MR eller CT skanning af disse områder for at sikre diagnosen, såfremt patienten udelukkende har knoglemanifestationer (1,2)

LVEF bestemmelse før eventuel antracyklin og trastumumab behandling iht. lokale retningslinier (3)

Klinisk foto ved evaluerbar sygdom i huden.

Ved kliniske fund suppleres med relevante parakliniske undersøgelser.

Der foreligger endnu ikke tilstrækkelig evidens for rutinemæssig anvendelse af PET skanning i forbindelse med udfordring af patienter med recidiv, derimod kan PET skanning være et redskab ved diagnostisk tvivl om, hvorvidt patienten har metastatisk sygdom (4).
18.3.2 Monitorering under behandlingen

- Der skal løbende foretages evaluering af behandlingseffekten med relevante paraclinsiske undersøgelser.

Afhængig af lokalisation kan dette omfatte:
- Perifere lymfeknuder: UL – objektiv undersøgelse
- Knoglemetastaser: MR-skanning, CT-skanning, røntgen
- Levermetastaser: CT-skanning, UL-skanning
- Lungemetastaser: CT-skanning, røntgen
- Pleuravæske: Røntgen
- Ascites: CT-skanning, UL-skanning
- Centrale bløddelsmetastaser: CT-skanning
- Kutan/subkutan synlig spredning: klinisk foto med mål
CRITERIA FOR RESPONSE EVALUATION - DBCG

- Ved endokrin behandling hver 3. måned; kan ved stabile forhold efter 6 måneder udstrækkes til hver 6. måned og ved yderligere stabile forhold endnu længere styret af den kliniske tilstand.

Evaluering af respons bør baseres på RECIST kriterier version 1.1, som har indarbejdet anvendelsen af de nyeste billeddiagnostiske undersøgelser.
[18F]Fluorodeoxyglucose (FDG)-Positron Emission Tomography (PET)/Computed Tomography (CT) in Suspected Recurrent Breast Cancer: A Prospective Comparative Study of Dual-Time-Point FDG-PET/CT, Contrast-Enhanced CT, and Bone Scintigraphy

ABSTRACT

Purpose To prospectively investigate the diagnostic accuracy of [18F]fluorodeoxyglucose (FDG)-positron emission tomography (PET)computed tomography (CT) with dual-time-point imaging, contrast-enhanced CT (cCT), and bone scintigraphy (BS) in patients with suspected breast cancer recurrence.

Patients and Methods One hundred women with suspected recurrence of breast cancer underwent 1-hour and 3-hour FDG-PET/CT, cCT, and BS within approximately 10 days. The study was powered to estimate the precision of the individual imaging tests. Images were visually interpreted using a four-point assessment scale, and readers were blinded to other test results. The reference standard was biopsy along with treatment decisions and clinical follow-up (median, 17 months).

Results FDG-PET/CT resulted in no false negative and fewer false positives than the other imaging techniques. Accuracy of results was similar for 1-hour and 3-hour FDG-PET/CT. For distant recurrence, the area under the receiver operating curve was 0.89 (95% CI, 0.79 to 1.00 for FDG-PET/CT), 0.84 (95% CI, 0.74 to 0.94) for cCT, and 0.75 (95% CI, 0.67 to 0.83) for the combined cCT-BS. For patients with suspected breast cancer, FDG-PET/CT was better than cCT alone or cCT combined with BS in diagnosing distant, local, and local recurrence, shown by a greater area under the receiver operating curve and higher sensitivity, specificity, and superior likelihood ratios.

Conclusions FDG-PET/CT was accurately in diagnosing recurrence in breast cancer patients. It allowed for distant recurrence to be correctly ruled out and resulted in only a small number of false-positive cases. Exploratory findings suggest that FDG PET/CT has greater accuracy than conventional imaging technologies in this patient group.

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Nuclear Medicine
Odense University Hospital Denmark

UNIVERSITY OF SOUTHERN DENMARK.DK
MULTIPLE TIME POINT FDG-PET

Malignant lesions

Physiologic tissue
METHODS

Bone scintigraphy
- Wholebody
- 700 MBq $^{99m}$Tc-DPD
- 180 min. after injection

ceCT
- Thorax and upper abdomen
- Diagnostic quality
- Contrast enhanced

Dual time FDG-PET/CT
- Skull to proximal femur
- 60 min. and 180 min. after injection
- 4 MBq/kg $^{18}$FDG
- Low dose CT

Blinded readings
- Four radiologists
- Two nuclear medicine physicians
ASSESSMENTS

4-point graded assessments

No
Probably no
Probable
Definite

signs of metastasis
ASSESSMENTS

Dichotomized assessments

<table>
<thead>
<tr>
<th>No</th>
<th>Metastasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probably no</td>
<td>No metastasis</td>
</tr>
<tr>
<td>Probable</td>
<td></td>
</tr>
<tr>
<td>Definite</td>
<td></td>
</tr>
</tbody>
</table>

No metastasis

Metastasis
PATIENT FLOWCHART

Suspected breast cancer recurrence
- Oncology (n=54)
- Breast Surgery (n=24)
- General practitioner (n=22)

Dual time FDG-PET/CT (n=100)
- Contrast enhanced CT (n=99)
- Bone scintigraphy (n=100)

- Negative scans
- One positive scan

Clinical follow-up 17 months (R 0-36)
- Biopsy or other imaging

Median time interval: 10 days (R 0-35, 110)

Gold standard
RECURRENCE

Distant recurrence
N=22 (22%)
Bone N=18 (18%)

Local recurrence
N=19 (19%)

No recurrence
N=59 (59%)

20 distant biopsies
2 local biopsies
10 patients died
12 patients alive

Clinical follow-up:
All patients alive
No with later distant recurrence

Clinical follow-up:
All patients alive
2 distant recurrences - after > 20 months

Clinical follow-up:
All patients alive
Figure 2
B Bone recurrence

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Estimate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDG-PET/CT (1h)</td>
<td>1.00 (0.82, 1.00)</td>
</tr>
<tr>
<td>FDG-PET/CT (3h)</td>
<td>1.00 (0.82, 1.00)</td>
</tr>
<tr>
<td>ceCT</td>
<td>0.61 (0.39, 0.83)</td>
</tr>
<tr>
<td>BS</td>
<td>0.78 (0.55, 0.91)</td>
</tr>
<tr>
<td>ceCT+BS</td>
<td>0.83 (0.61, 0.94)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specificity</th>
<th>Estimate (95% CI)</th>
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<tbody>
<tr>
<td>FDG-PET/CT (1h)</td>
<td>0.96 (0.92, 0.99)</td>
</tr>
<tr>
<td>FDG-PET/CT (3h)</td>
<td>0.96 (0.91, 0.99)</td>
</tr>
<tr>
<td>ceCT</td>
<td>0.99 (0.93, 1.00)</td>
</tr>
<tr>
<td>BS</td>
<td>0.87 (0.78, 0.92)</td>
</tr>
<tr>
<td>ceCT+BS</td>
<td>0.85 (0.70, 0.91)</td>
</tr>
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AUC-ROC FOR BONE RECURRENCE

18 patients had bone metastases
A total of 488 lesions were detected in 18 patients
A median of 5 lesions per patient (Range: 1 – 99)
BS showed 4 patients with superscan
7 (of 18) patients had multiple bone metastases (> 10 lesions)
CT CLASSIFIED BONE LESION TYPES

<table>
<thead>
<tr>
<th>Lesion type</th>
<th>Number of lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lytic</td>
<td>213 (44 %)</td>
</tr>
<tr>
<td>Sclerotic</td>
<td>80 (16 %)</td>
</tr>
<tr>
<td>Mixed</td>
<td>97 (20 %)</td>
</tr>
<tr>
<td>Invisible</td>
<td>98 (20 %)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>488</strong></td>
</tr>
</tbody>
</table>
### LESION BASED SENSITIVITY

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<tr>
<th>Modality</th>
<th>Sensitivity % (95 % CI)</th>
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<tbody>
<tr>
<td>FDG-PET/CT 1h</td>
<td>98.6 (96.9-99.4)</td>
</tr>
<tr>
<td>FDG-PET/CT 3h</td>
<td>99.0 (97.5-99.6)</td>
</tr>
<tr>
<td>CT</td>
<td>79.9 (76.0-83.3)</td>
</tr>
<tr>
<td>BS</td>
<td>76.0 (71.9-79.7)</td>
</tr>
<tr>
<td>BS and CT combined</td>
<td>98.6 (96.9-99.4)</td>
</tr>
</tbody>
</table>

- 5 osteolytic lesions located in the skull were not detected on FDG-PET/CT
- BS detected significantly less of the osteolytic metastases (104/213; Sens 49 %) than of other metastatic types (267/275; sens 97 %)
QUANTIFICATION OF BONE METASTASES

Boxplot of the median cSUVmean of one-hour (1h) and three-hour (3h) for classified types of bone metastases.
Artiklen anbefaler: Helkrops-MR, alternativt FDG-PET som førstevalg til opsporing af knoglemetastaser for alle andre cancertyper end prostata, hvor Fluorid eller Cholin anbefales.
HEALTH TECHNOLOGY ASSESSMENT

- Technology
- Patient
- Organisation
- Economy