

# BREAST CANCER

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*Norbert Avril*

### **F-18 Fluorodeoxyglucose-Positron Emission Tomography Imaging for Primary Breast Cancer and Loco-Regional Staging** **1**

*Norbert Avril and Lee P. Adler*

Breast cancer is the most common female malignancy in Western countries. The limitations of mammography, ultrasound and MRI do not allow reliable identification of primary breast cancer at early stages. Functional breast imaging with positron emission tomography (PET) and F-18 fluorodeoxyglucose (FDG) enables the visualization of increased glucose metabolism of breast cancer. However, despite the successful identification of primary breast cancer, FDG-PET provides a low sensitivity to detect small tumors. Therefore, FDG-PET does not allow screening of asymptomatic women and cannot be used to exclude breast cancer in patients with suspicious breast masses or abnormal mammography. FDG-PET is a powerful tool for staging of breast cancer patients, but does not detect micrometastases and small tumor infiltrated lymph nodes. Nevertheless, in patients with locally advanced breast cancer, PET accurately determines the extent of disease, particularly the loco-regional lymph node status. Advances in technology, for example the development of dedicated breast imaging devices such as positron emission mammography, hold promise to improve the detection of primary tumors in the future.

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*William B. Eubank*

One of the major strengths of F-18 fluorodeoxyglucose-positron emission tomography (FDG-PET) in breast cancer imaging is in the evaluation of patients who have suspected loco-regional recurrence or distant metastasis. In general, FDG-PET is more sensitive than conventional imaging for the detection of recurrent disease. Because of its ability to more accurately stage patients who have advanced breast cancer, FDG-PET has a significant impact on choice of treatment and management in this patient group.

**Detection of Bone Metastases in Breast Cancer by Positron Emission Tomography 25***Holger Schirrmeister*

Positron emission tomography (PET) is able to demonstrate changes in the metabolism of malignant tumors and metastases before they become visible on anatomical imaging. The skeleton is the most common site of distant metastases of breast cancer. There is convincing evidence that FDG-PET is more sensitive in detecting osteolytic metastases than bone scintigraphy, whereas bone scintigraphy is more sensitive in detecting osteoblastic metastases. Because both types of metastases can occur in breast cancer, bone scintigraphy and FDG-PET should be considered as complementary and can currently be regarded as standard of care for staging in breast cancer patients, whereas the decision to use F-18 fluoride PET should be made individually for each patient, depending on the expected change of therapy management.

**Instrumentation for Positron Emission Mammography 33***Christopher J. Thompson*

Positron emission tomography (PET) is becoming widely accepted for the diagnosis and staging of cancer. Whole-body PET can detect not only primary breast cancer but distant metastases as well. Recently, several groups have developed small PET instruments specifically for the detection of primary breast cancer. These positron emission mammography (PEM) scanners, have the potential of being less expensive and providing higher spatial resolution than whole-body scanners. Several designs are compatible with conventional mammography and can combine the structural imaging of radiograph mammography with the functional imaging of PET in a manner similar to PET-CT scanners. This article explores the requirements to obtain good quality PEM images and various designs that have been implemented, and provides some examples of PEM images.

**FDG-PET and PET/CT in Radiation Therapy Simulation and Management of Patients Who Have Primary and Recurrent Breast Cancer 39***Dwight E. Heron, Sushil Beriwal, and Norbert Avril*

Radiation therapy is an important component in breast cancer management. Localization and delineation of gross tumor volumes is determined by anatomical imaging using CT and MRI. Recent developments allow the delivering of radiation doses more conformally to tumor tissue; thus precise target definition is needed to spare normal tissues and maximize coverage of tumor volumes in conformal radiation techniques. Defining disease extent, monitoring response, and predicting tumor behavior is vital to tailoring definitive radiotherapeutic regimens. Positron emission tomography (PET) imaging using [F-18] fluorodeoxyglucose (FDG) may play a significant role in the future. This article explores the increasing roles of FDG-PET and PET-CT in target definition and radiation treatment planning, and their possible application in the treatment of breast cancers.

**Steroid Receptor Imaging in Breast Cancer 51***Jean-Mathieu Beaugerard, Éric Turcotte, and François Bénard*

A high proportion of breast cancers express estrogen and progesterone receptors. This can guide oncologists on hormonal therapy's suitability for breast cancer. With second-line hormonal therapy agents such as aromatase inhibitors and pure antagonists, imaging methods could be critical in assessing the presence of estrogen or progesterone receptors. Several radiopharmaceuticals were developed for imaging of estrogen or progesterone receptors. Estrogen receptor imaging could play a useful role in predicting the response of breast cancer to hormone therapy. Large-scale trials will determine the respective roles of

tamoxifen, aromatase inhibitors, and fulvestrant, and the optimal drug administration sequence. Early noninvasive identification of patients who will likely fail all forms of hormonal therapy could be achieved by positron emission tomography.

### **Changes in Glucose Metabolism and Blood Flow Following Chemotherapy for Breast Cancer**

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*David A. Mankoff and Lisa K. Dunnwald*

This article focuses on this application of positron emission tomography (PET) to breast cancer. The article first reviews the PET methodology used for breast cancer response assessment, with an emphasis on quantitative methods. This is followed by a review of results to date for neoadjuvant chemotherapy and therapy of metastatic breast cancer. Preliminary studies with tracers other than  $^{18}\text{F}$ -fluorodeoxyglucose are then reviewed. The article ends with a summary and a discussion of future directions.

### **Histopathologic and Metabolic Criteria for Assessment of Treatment Response in Breast Cancer**

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*Stefanie Sassen, Falko Fend, and Norbert Avril*

Increasing use of neoadjuvant chemotherapy in locally advanced breast cancer necessitates methods for evaluation of therapeutic response. Histopathology provides accurate assessment of treatment efficacy but only approximately 20% of breast cancer patients achieve complete pathologic response after neoadjuvant chemotherapy. Therefore, methods that predict therapeutic effectiveness could help individualize treatment and avoid ineffective chemotherapies. Metabolic imaging using positron emission tomography (PET) and F-18 fluorodeoxyglucose (FDG) seems to provide early response assessment in vivo. Change in FDG uptake after chemotherapy initiation correlates with histopathologic response after completion. PET response assessment criteria and imaging protocols need to be developed and validated. This article compares complementary approaches for assessment of treatment response, namely histologic features of the tumor on the microscopic level versus in vivo metabolic changes on a macroscopic level.

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