Positron Emission Mammography: Can it help evaluation of breast lesions when used together with other imaging modalities?

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Learning objectives

To evaluate the indications and illustrate the findings of positron emission mammography (PEM) and its correlations with other breast imaging modalities.

Background

The diagnosis of breast cancer is based on a multimodal approach. The correlation of the results of mammography, ultrasound and MRI has been useful in the evaluation of breast lesions. Recently, functional and molecular imaging has been used to improve characterization of breast cancer in specific scenarios such as high-risk women, dense breasts, multiple lesions, postoperative scar, etc. [1,2] For patients with breast cancer, Positron Emission Tomography / Computed Tomography (PET/CT) with 18F-FDG has a proven role in detecting distant metastasis, recurrence and evaluating therapeutic response. [3] Previous studies have shown that PET/CT can help in the characterization of primary breast lesions. [4,5] However, its main limitation is the relative low spatial resolution, which limits the evaluation of small breast lesions (smaller than 10 mm). In this context, a new technology called PEM was designed for the imaging of breast tissue with high-resolution detection of FDG uptake.

Findings and procedure details

Positron emission mammography (PEM) is a new imaging method that, unlike conventional methods, allows evaluation of the glucose metabolism of breast lesions. This test has the following main advantages over PET/CT: high spatial resolution, able to identify lesions up to 2 mm; easier correlation with mammography; possibility of guided percutaneous biopsy. [6]

The images of the breasts with PEM are made at a specific unit (Figure 1) after intravenous administration of the radiopharmaceutical (FDG). The examination is performed with the patient in the sitting position. By lightly compressing the breast tissue during acquisition, the image can be acquired in incidences that are analogous to those used in mammography (CC and MLO views), which allows for image coregistration and comparison. [7] Usually 12 pictures of each breast for each incidence are obtained (Figure 2). Additional incidences can be obtained for imaging the axilla (Figure 3). Areas of high glucose metabolism on PEM are categorized as focus, mass or non-mass FDG uptake. [8]
This method has demonstrated high diagnostic accuracy for primary breast lesions, including carcinoma in situ, with sensitivity and specificity of up to 91% and 93%, respectively. Even in very small tumors measuring <1 cm, the imaging sensitivity of PEM has been reported to be up to 70% (Figure 4). PEM have shown to have comparable diagnostic accuracy to MRI in the diagnosis of breast cancers. [9,10]

The primary indication for PEM is the detection and characterization of breast lesions. It is often used in preoperative surgical planning or prechemotherapy evaluation for patients who are considering breast conservation surgery to evaluate for multifocal or multicentric disease (Figure 5), mainly in whom MRI may be contraindicated. Other indications are response evaluation after neoadjuvant chemotherapy and inconclusive findings on conventional breast imaging, such as distinguishing recurrent carcinoma from scar. [11-15]

The PEM findings should always be associated with clinical data and conventional imaging (mammography, ultrasound and MRI) to enable proper management. In the evaluation of a known breast lesion, the higher the FDG uptake in the lesion, the greater the risk of malignancy (Figure 6). Some benign lesions may show mild increased FDG uptake (Figure 7). [16] Besides, we know from previous PET-CT studies that breast carcinomas have variable FDG uptake, which is directly related to tumor aggressiveness and prognosis. [17-19] The following factors are associated with higher FDG uptake in malignant lesions: histological type and grade, molecular subtype, tumor diameter, mitotic index and Ki-67 expression. As regards histological type, invasive ductal carcinomas usually show higher FDG uptake than other types of breast cancer, such as invasive lobular carcinoma and ductal carcinoma "in situ". Thus, careful analysis of PEM images is necessary to identify possible low-grade tumors with mild FDG uptake (Figure 8).

PEM can also be used to guide percutaneous biopsy of positive findings, which is a safe and effective procedure, allowing the collection of material from the most metabolically active area. [20]

Images for this section:
Fig. 1: PEM device.
**Fig. 2:** Example of images obtained with PEM (MLO incidence): 12 pictures of each breast (lateral to medial), showing a mass with intense FDG uptake in the upper quadrants of the right breast.

![Image of breast with mass]

**Fig. 3:** Example of axillary view images obtained with PEM showing moderate uptake on an enlarged lymph node in the right axilla (A) and a mild uptake on a normal-sized lymph node in the left axilla of another patient (B).

![Image of axillary view with lymph nodes]
Fig. 4: PEM images showed a small focus of increased FDG uptake on the upper-outer quadrant of the right breast, which was confirmed as a 5 mm invasive ductal carcinoma after ultrasound-guided biopsy.
**Fig. 5:** Example of a multifocal carcinoma in the left breast. PEM showed intense FDG uptake on the main lesion in the lower-inner quadrant and in two adjacent smaller lesions on the medial quadrants junction. There was also mild FDG uptake on left axillary lymph nodes, which were positive on sentinel lymph node biopsy.

**Fig. 6:** Patient with bloody nipple discharge on the left breast. At mammography (A: CC view), a periareolar obscured mass was observed on the upper-outer quadrant of the left breast. Ultrasound (B) and MRI (C) confirmed a circumscribed mass with
homogeneous enhancement. PEM (D: CC view) showed mild FDG uptake in the same topography, suggestive of a benign lesion. Histopathological diagnosis confirmed an intraductal papilloma without atypia.

**Fig. 7:** Patient with a palpable lump in the right breast. Mammography (A: spot compression) showed an irregular mass in the upper-outer quadrant, which corresponded to a microlobulated hypoechoic mass on ultrasound (B). MRI (C) showed an irregular mass with heterogeneous enhancement and intense FDG uptake on PEM (D: MLO view). Pathological findings confirmed a high-grade invasive ductal carcinoma.

**Fig. 8:** Screening mammography (A: MLO view) showed an area of architectural distortion in the upper quadrants of the right breast. On MRI (B), a heterogeneous non-mass enhancement was observed in the same topography. PEM (C: MLO view) showed
a focal area of mild heterogeneous non-mass uptake. Histological examination showed a small invasive lobular carcinoma associated with ductal carcinoma “in situ”.
Conclusion

Our initial experience shows that PEM is a promising method of image that can be useful in the evaluation of suspicious breast lesions. The inclusion of PEM in multimodal and comparative analysis of the breast has shown significant relevance to assist in the early diagnosis and determine changes in the therapeutic approach.

Personal information

References