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PET/CT and PET/MRI image fusion for breast cancer

W.V. Vogel, Amsterdam (NL)

Abstract

FDG-PET imaging of primary breast cancer tumors is currently not a generally accepted indication. This is explained by scientific research in the early days of PET imaging, that demonstrated poor visibility of tumors with FDG within surrounding glandular tissue, and poor anatomical localization of lesions within a breast on PET alone. On the other hand, MRI is now developing as a standard tool for breast imaging. New technological developmens may change the situation in the coming years. Compared to first-generation devices, current PET-scanners provide a much higher spatial resolution, contrast resolution, and sensitivity. Integrated PET/CT scanners have allowed direct localization of lesions detected on PET on anatomical CT images. FDG-PET is now once again considered for staging of breast cancer (1). As a next step, integration of PET and MRI may allow direct correlation of lesions for diagnosis, biopsy, surgical planning, and response monitoring (2).

Positioning

Correlative imaging of breast tissue requires adequate anatomical positioning in a stable and reproducible setup. Several options for patient positioning are available and in use. Supine positioning is appplied for ultrasound, biopsies, and wholebody PET and PET/CT imaging. Compressed imaging is the standard for mammography, and is currently also introduced for novel positron emission mammography devices. Prone positioning (with hanging breasts) is applied for MRI and MRS, stereotactic biopsy, and sometimes for breast irradiation. The prone approach may also be suitable for PET and PET-CT imaging, to allow direct voxel-based correlative imaging with PET, CT and MRI. This approach is interesting but not straightforward. Due to the deformability of breast tissue, positioning systems and patient instructions needs to be equal in all imaging modalities. This should limit attempts with handmade materials such as cushions with holes.

Image fusion

Anatomical correlation between image sets can be achieved with an integrated scanning device, but this is not yet available for PET and MRI. Therefore, patients will have to be repositioned in multiple gantry's. This will cause minor positional differences despite optimal positioning systems in all cases – especially in breast tissue – that will need additional software fusion optimization afterwards. Image registration will not be not easy, due to the lack of any landmarks within breast tissue on PET. The presence of anatomical landmarks on CT may allow image fusion via an indirect approach.

Options for correlative diagnosis

Interesting new options for imaging of breast cancer may emerge when integrated PET/CT and PET/MRI become available. Lesions that are detected on MRI but cannot be discriminated between tumor and benign, may be characterized by FDG metabolism and thus saving biopsies. On the other hand, lesions that were detected with FDG may be correlated with MRI, to guide biopsies and surgery to the most aggressive tumor parts. Finally, MRI is currently emerging as a tool for response monitoring of breast tumors during chemotherapy by analysis of local changes in tissue perfusion. But not all tumors may respond with changes in tissue perfusion, or not very early. PET-based response monitoring may add important information (3). In these and other cases, integrated FDG-PET/MRI may have a future with several new indications.

References

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