New PET technologies

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Chapter 7

First-time imaging of ^{89}Zr-trastuzumab in breast cancer using a long axial field-of-view PET/CT scanner

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Long axial field-of-view (LAFOV) PET/CT scanners have been introduced recently (1, 2), which offer numerous advantages (3). One important advantage of using LAFOV PET for imaging ^{89}Zr-labeled monoclonal antibodies (mAbs), i.e., immunoPET, is the substantial increase in sensitivity compared with standard axial field-of-view (SAFOV) PET/CT systems, which may lead to a remarkable image quality improvement. This first study showcases such improvement in immunoPET imaging with the Biograph Vision Quadra (VQ) LAFOV PET/CT (Siemens Healthineers).

Two patients suffering from metastatic HER2-positive breast cancer were administered with 37 MBq ^{89}Zr-trastuzumab in order to assist clinical decision-making (4, 5). Patients were scanned 4 days postinjection with a Biograph mCT PET/CT (patient A) (Siemens Healthineers) or a Biograph Vision PET/CT (patient B) (Siemens Healthineers), according to local standard operating procedures with overall scan durations of 45 min and 32 min, for, respectively, mCT and Vision. Following the clinical scans, patients were scanned with the VQ. For the VQ, we chose to apply a long scan duration of 30 min (patient A) and 32 min (patient B) to improve image quality rather than shortening the overall scan duration, as compared to Vision. For SAFOV systems, the acquisition and reconstruction parameters complied with European Association of Nucelar Medicine Research Ltd. (EARL) 1 standard specifications, whilst for LAFOV, we also applied vendor-recommended settings for optimized imaged quality for clinical reading (CLIN) (see Table 1) (6, 7). PET/CT images of patient A are shown in the top two rows (*a-h*), for patient B in the bottom two rows (*i-p*). The same intensity scale, SUV range 0-10, applies for all images, except the fused images (*e, m*). Additional reconstructions of the VQ data were obtained, mimicking 3-min (*d, h, l, p*) and 10-min (*c, g, k, o*) acquisitions, illustrating more pragmatic scan durations.

As can be appreciated from these first human immunoPET images on an LAFOV system, the image quality improvement (*f*) is most spectacular when compared with the mCT (*a*). For example, in patient A, an additional small bone lesion was visualized with the VQ in the pelvic area (*f*), which was not visible with the SAFOV system (*a*). Even when compared to the Vision (*i*), the VQ image (*n*) shows improved quality without applying any filter after reconstruction. Moreover, this visual improvement in image quality was even appreciated in the 10 min image compared with the 30-45 min acquisition needed for SAFOV systems.

Thus, this image shows that the large axial FOV system provides substantial improvement in image quality when applying currently preferred total scan durations on SAFOV systems (45 min for mCT, 32 min for Vision). Additionally, with the new LAFOV system, there is room for further reduction of the scan duration with still very acceptable image quality, even for ^{89}Zr-labeled mAb PET/CT studies.

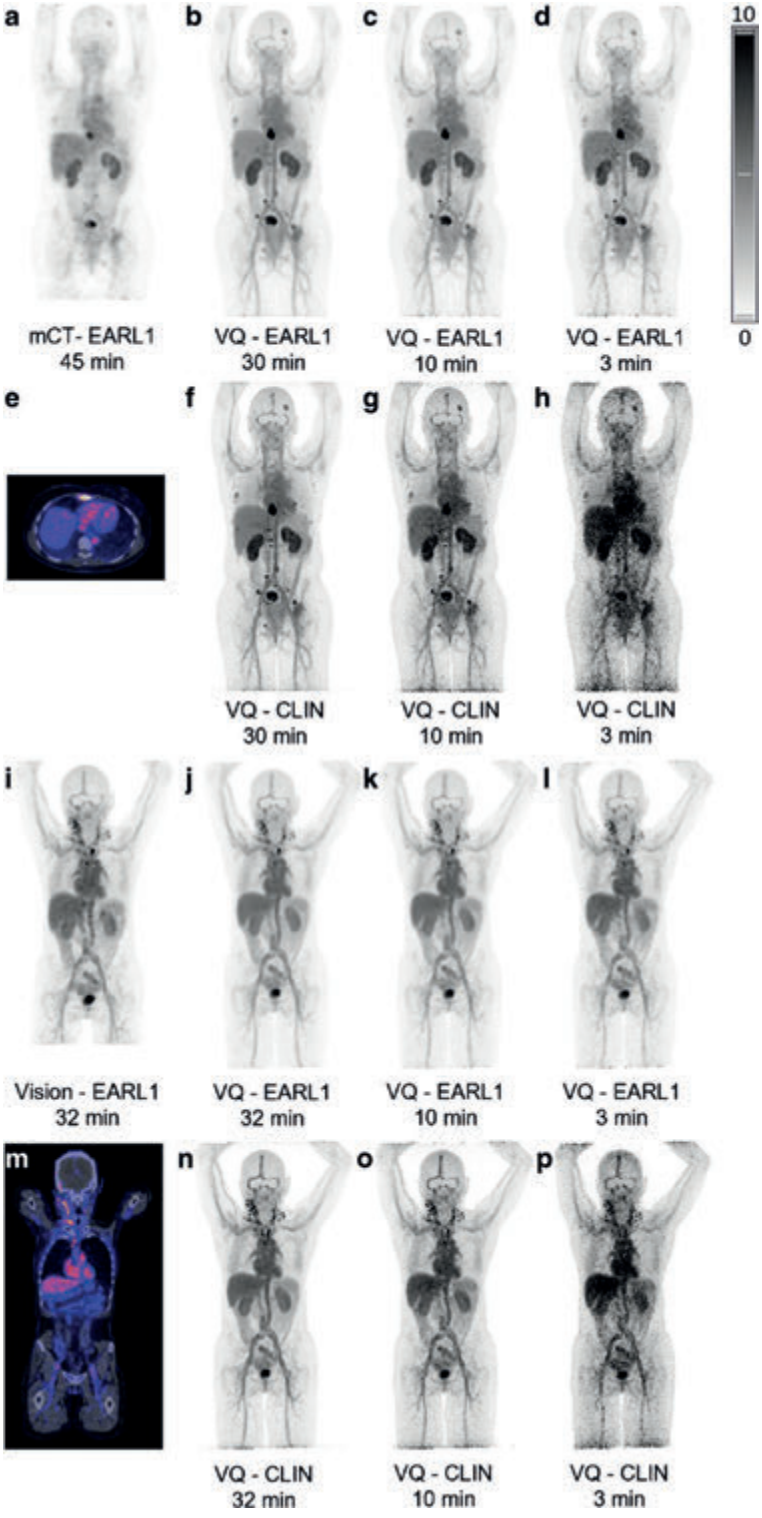
a
b
c
d
10
0
mCT- EARL1
45 min
VQ - EARL1
30 min
VQ - EARL1
10 min
VQ - EARL1
3 min
e
f
g
h
VQ - CLIN
30 min
VQ - CLIN
10 min
VQ - CLIN
3 min
i
j
k
l
Vision - EARL1
32 min
VQ - EARL1
32 min
VQ - EARL1
10 min
VQ - EARL1
3 min
m
n
o
p
VQ - CLIN
32 min
VQ - CLIN
10 min
VQ - CLIN
3 min

Table 1 *Acquisition and reconstruction parameters for the different systems.*

PET/CT system	Acquisition method	Reconstruction protocol name	Reconstruction settings
Biograph mCT	Step-and-shoot: 5 min per bed position (bp), 9 bp in total	EARL1	3D OP-OSEM, 3i21s with ToF + PSF, matrix size 256x256x488 with voxel size 3.2x3.2x2.0 mm^3, 6.5 mm FWHM Gaussian filter
Biograph Vision	Flow: 8 min per whole body CBM pass, 4 passes	EARL1	3D OP-OSEM, 4i5s with ToF + PSF, matrix size 220x220x706 with voxel size 3.3x3.3x1.5 mm^3, 7 mm FWM Gaussian filter
Biograph Vision Quadra	Single bp	EARL1	3D OP-OSEM, 4i5s with ToF + PSF, matrix size 220x220x708 with voxel size 3.3x3.3x1.5 mm^3, 7 mm FWHM Gaussian filter
	Single bp	CLIN	3D OP-OSEM, 4i5s with ToF + PSF, matrix size 440x440x708 with voxel size 1.6x1.6x1.5 mm^3, no filtering

EARL = European Association of Nuclear Medicine Research Ltd; 3D OP-OSEM = three dimensional ordinary poisson ordered-subset expectation maximization; i = iterations; s = subsets; ToF = time-of-flight; PSF = point spread function (resolution modeling); FWHM = full width at half maximum; CBM = continuous bed motion

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