Shortened Dynamic ^{18}F-FDG PET

TO THE EDITOR: With great interest we read a recent article by Strauss et al. (*1*). The authors describe a support vector machine–based method to predict the parameters of the 2-tissue-compartment model from shortened dynamic ^{18}F-FDG PET acquisitions by analyzing a large database of 1,474 time–activity curves obtained from 539 patients. Shortening the standard 1-h protocol to more convenient acquisition times of less than 30 min would not only improve patient comfort but also reduce demand on camera time and facilitate scheduling of dynamic scans. In this manner, the likelihood that dynamic PET will actually be used for routine imaging purposes would increase. The authors have shown that their method can accurately estimate tumor microparameters using a short dynamic ^{18}F-FDG PET scan. However, we wish to suggest additional analyses.

Accumulation of ^{18}F-FDG in a tumor increases with time. Hamberg et al. (*2*) have shown a continuing rise in standardized uptake value in some lung tumors even several hours after injection. With decreasing blood concentrations, the tumor-to-background ratio continues to increase, but conversely, the decreasing counting rates as a result of the physical decay of ^{18}F dictate an upper limit to the optimal uptake period. Most optimized protocols advise that acquisition of static PET scans begin at least 45 min after administration of ^{18}F-FDG (*3,4*), and many centers use an uptake period of about 60 min.

Volumes of interest (VOIs) to assess uptake or pharmacokinetic parameters are often defined on a threshold basis, such as the 3-dimensional isocontour at 50% of the maximum voxel value within a lesion. Other methods include manually placed VOIs or fixed volumes. These methods have variable advantages and limitations, but all have in common that voxels included in the VOI defined at an earlier time point may differ from those defined in the final time frame. Also, with manually placed VOIs it may be difficult to accurately delineate the lesion, as the contrast is still relatively low at an earlier time point. Consequently, the lesion's time–activity curve can differ as well, which, in turn, could alter the parameters of the 2-tissue-compartment model.

In our experience, the VOI often differs significantly depending on time after injection. The Jaccard index (*5*) can be used to determine the similarity between 2 VOIs, defined as the number of overlapping voxels divided by the number of voxels in both or any of the VOIs. Comparing VOIs defined in early time frames and the final time frame shows a gradually decreasing similarity. Especially with scans of less than 30 min, the index can become relatively low, because of insufficiently high tumor-to-background ratios. Obviously, with a short dynamic PET acquisition and an additional time frame at 60 min after injection, as also described by Strauss et al., accurate VOI definition is no longer a problem as long as both scans can be registered properly. However, the benefits of a shortened acquisition period would be reduced.

Strauss et al. appear to have shortened the dynamic PET scan by removing time points from the original time–activity curves, without redefining the VOIs in the earlier time frames—at least, this is not mentioned in their paper. We would be interested in the combined effect of redefining VOIs on the shortened acquisition and the significantly shorter time–activity curve. When the parameters of the 2-tissue-compartment model can still be estimated with great accuracy, shortened dynamic PET acquisitions could be a valuable addition to standard, static, ^{18}F-FDG PET.

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REPLY: Dr. Disselhorst and colleagues note that most protocols use at least 45 or 60 min for data acquisition. This is absolutely correct if the standard Levenberg–Marquardt algorithm is used to calculate the compartment parameters. In our work (*1*) we use a predictive algorithm, which predicts the 60-min compartment results from a shortened data acquisition. Only with a predictive algorithm may compartment parameters be calculated accurately from a shortened acquisition series.

With regard to positioning of VOIs, the database contains results from 60-min series, and the VOIs are always placed on the last frame of the series and on the 60-min images (e.g., 20-min series plus 60-min whole-body images). For full dynamic series (60-min dynamic acquisition), the last frame is used for positioning of VOIs. Of course, for the input VOI, the first frames are the most important and are used for positioning. The CT images from PET/CT are usually helpful to support positioning of VOIs. Because whole-body imaging is done in all oncologic patients, the 60-min data are always available, even for a shortened acquisition series. Therefore, lesion contrast is usually not a problem. In the clinical environment, it is not the aim to assess exclusively the highest tracer accumulation but to match a lesion as defined on CT or MR images with the corresponding finding on