

Methods to Outline the Patient During Lymphoscintigraphy

TO THE EDITOR: It was with great interest that we read the article about outlining methods for lymphoscintigraphy, and we applaud the additional described method that uses a ^{153}Gd -line source (1). It provides an option for those centers that have this capability installed on their SPECT cameras. However, we disagree with the statements in the article concerning the inability of the ^{57}Co -flood source method to obtain lateral images. This is simply not so. In fact, we have been using the ^{57}Co -flood source method to obtain excellent outlined lateral images for several years (2,3). Simply placing the sheet source on a chair with the patient between the flood source and camera head clearly provides the necessary geometry to produce the desired results.

Although it is conceivable that certain camera configurations (multihead and ring gantry based) could create geometry issues for the sheet source method, geometry issues have not prevented lateral views in our own triple- and dual-head camera systems, which are similar in physical configuration to other systems available. To outline the body of the patient in the lateral view, the sheet can be placed on any suitable surface (adjustable chair or stool below the opposing head[s]) or even hung from suitable attachment points (gantry, swing arm, etc.). One system we use has long hook-and-loop strips to hang the sheet source from the opposing camera head or arm. Outlined images can also be obtained with oblique (45° , etc.) camera angles.

In addition, the lateral images obtained with the ^{57}Co -flood source method are superior to the anterior images obtained with this same method. This superiority is due to the greater effective patient cross-sectional distance/mass involved and the resultant increase in attenuation compared with the effective cross-sectional distance with anterior views. With increased attenuation, the patient outline is better defined and the sentinel node is easier to detect against a background of activity that is less than that obtained with anterior views.

Given the lower-energy 122-keV photons of ^{57}Co , separate energy windows in the 122-keV range, in addition to conventional 140-keV windows (or upwardly offset windows to reduce scatter for better sentinel node delineation), could be used and printed separately and/or combined to optimize outlining when the ^{57}Co -flood source is weak, and to minimize exposure if deliberately using a weak ^{57}Co -flood source.

Finally, although the image quality obtained with a ^{153}Gd -line source is of very high quality, this method is possible only with select new camera systems and is not as readily available as is a ^{57}Co -flood source, which is already present in most nuclear medicine departments.

In discussing outlining methods, the authors did not mention 2 other methods that can be used to outline the patient.

The first is a simple "activity background painting" method in which activity in a 10-mL syringe is waved behind the patient in a pattern that sweeps across a plane parallel to the entire collimator surface, in effect simulating a ^{57}Co -flood source. This method uses the same principles of differential attenuation as do other methods. The method can be used when no ^{57}Co -flood source is available or when the source has decayed. The method is inexpensive, readily available, and quick. Issues of exposure can be controlled by

limiting the activity in the syringe. The main drawback of the method is in the need for a certain level of skill to evenly sweep the activity behind the patient to achieve a uniform outline. Nevertheless, minor irregularities are not a significant distraction, and this method is superior to the method of manually moving a point source around the patient edge while acquiring an image.

The second method uses internal patient scatter from the injection site to generate an outlined image. An additional very-low-scatter energy window is programmed into the camera system (approximately 85–115 keV) to create a body-contour outline using scatter from the injection site (2,4). This image can be combined with the standard $^{99\text{m}}\text{Tc}$ energy window images to obtain a composite image delineating the position of the sentinel node in relation to the patient's body. Drawbacks to this method include poor image quality in many patients, additional complex image-processing steps, and the need to often normalize the image set to obtain usable results (2).

No matter which method is ultimately used for outlining, we strongly believe that the surgeons should be presented with 4 images at a minimum. A set of 2 anterior images should be obtained—an image obtained with no outlining method, and a subsequent same-view image obtained immediately afterward with outlining. A second set of images with and without outlining should be obtained for the lateral views. This allows for a better delineation of the sentinel nodes and will alert the surgeon to any rare artifacts that might be generated by the outlining process and occasional decreases in contrast from activity that shines through from the outlining sources themselves that could hide faint nodes.

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REPLY: Thank you for the comments regarding lateral views obtained using a ^{57}Co -flood source. It was interesting to read about obtaining lateral outline images using sheet sources suspended from the ceiling. This may be the only alternative for obtaining body-outline images with a camera that has no attenuation correction facility. However, we would be concerned with the health and safety issues raised by placing a sheet source on a chair or suspending a sheet source from a suitable point. The reason for finding an alternative was to reduce radiation exposure to the patient and the technologist as well as obtain better-quality images. As stated

in the article (1), the dose from a ^{57}Co -flood source is $70\ \mu\text{Sv}$, a 25% increase in total patient study if only anteroposterior images are acquired and a 75% increase if anterior, lateral, and oblique images are obtained. Exposure to the technologist would also be considerably increased from positioning the flood source for all views.

We acknowledge that there are also other outline methods; their existence reflects the fact that none is 100% satisfactory. We quoted only those that we had tried. The final method using the ^{153}Gd -line source gave superior images, and if the camera has the capability then this is the safest and easiest outline to achieve from any angle.

We strongly agree that all views should be available to the surgeon to aid in speedier localization of the lymph nodes during surgery.

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Effect of Acquisition Orbit on SPECT in Phantoms

TO THE EDITOR: The recent article by Liu et al. (1) presents data that challenge widely accepted standards of practice used in most clinical rotational SPECT myocardial perfusion protocols performed today. The focus of that article was on the increased inhomogeneity of circumferential count profiles (CCP) acquired with a 180° orbit in comparison with profiles from studies acquired with a 360° orbit. This observation was based on simplistic phantom data acquired using 1 specific dual-head SPECT camera (Millennium VG; General Electric Medical Systems). The authors also mentioned correlative data acquired using a triple-head camera as being “entirely consistent with those acquired by the dual-head system,” and if we accept their conclusion without qualification, the current standard of clinical practice should immediately be revised to adopt 360° orbits in deference to 180° orbits.

We are particularly concerned that the CCP curves from the reconstructed phantom data taken in a “centered” position (their Fig. 4) demonstrated a 3-cycle sinusoidal “wavy” artifact (WA) averaging about 15% peak-to-peak amplitude, which the authors described as “presumably caused by photon scatter and self-attenuation and perhaps by imprecise positioning of the phantom.” They went on to include the observation that the “wavy ‘normal’ circumferential count profiles of the phantom in the center position may be caused by a slight deviation of the long axis of the phantom from the centerline of the table,” and as further explanation for this WA, they “noted a slight wobble on cine display” observed during playback of the phantom data. The authors were aware that rotational tomographic imaging of this phantom, symmetrically positioned at the center of the orbit, should produce essentially flat or uniform CCP curves; however, this discrepancy in their data did not prompt further investigation. They did note that this variability was considerably worse (30% peak-to-peak) for 180° data collected 15 cm off the center of rotation. This result was consistent

with distance and resolution variations occurring throughout the off-center orbit. These variations tended to balance out for the 360° orbit, but the WA is still present, although to a lesser degree.

Among the significant impediments facing contemporary nuclear cardiology is the unimpressive specificity and reproducibility consistently demonstrated in the diagnostic accuracy reported for clinical myocardial perfusion studies. We have observed that many definitive studies, including that of Liu et al. (1), pass by the opportunity to conduct further objective testing that might shed important light on some of the fundamental shortcomings of rotational SPECT. Another recent article with which we take exception, by Blagosklonov et al. (2), stopped just short of running correlative tests and performing additional analytic steps, which could be very helpful in enhancing our understanding of the root causes contributing to the disappointing specificity and reproducibility experienced in the clinical application of myocardial perfusion studies.

We feel strongly that the WAs noted in this article (1) are not a minor issue and that their presence casts doubt on the validity of the data and the conclusions presented there. To expand on this point regarding the data presented in this article, it is important to identify the source of the WA as originating from 1 of 3 nominal error sources (systematic, experimental, or analytic). One fact that is clear from the article concerns the angular dependence of the problem, and so one should focus primarily on investigating those aspects of system performance, experimental design, and data analysis that can potentially alter resolution, sensitivity, or geometric registration as a function of viewing angle. Within this framework, we suggest 3 areas for further investigation that might be helpful in at least identifying the level of the problem: systematic errors, experimental errors, and analytic errors.

Regarding systematic errors, those aspects of system performance that are most likely to exhibit angular dependence include problems related to (a) the precision and uniformity achieved in the construction of the collimators, (b) the electromechanical precision, the pointing accuracy and reproducibility with which the detectors are moved through their orbits, and (c) the electrical stability of the images registered in the computer from the detectors. These types of problems can usually be selectively investigated by imaging point sources in appropriate configurations—for instance, (a) imaging a point source at a distance of 3–4 m to check collimator performance, (b) at the center of rotation to check the pointing accuracy and reproducibility of the orbit, and (c) fixed to the surface of the collimator to check image registration. Cine playback of the point source data provides a quick-look option for demonstrating obvious problems, but detection of more subtle sources of error requires customized software to perform rigorous analysis of peak location, center of mass, full width at half maximum, and the integral sensitivity of the individual images. Note that support stands which hold the detectors in a cantilevered position, such as the SPECT system used in the study of Liu et al. (1), are more susceptible to errors in the pointing accuracy associated with the collected views.

Regarding experimental errors, certain aspects of the experimental setup used in the work of Liu et al. (1) need to be looked at more closely, including the test fixture (clamp) used to hold the phantom, which appears to extend longitudinally some distance along the base (open end) of the phantom and places attenuating and scattering material (compressible layers and wood clamps) close to the radioactive wall of the phantom. This is of particular concern because the configuration of the clamp has cyclic rota-

tional symmetry, which conceivably could cause a high-order, multiple-scatter phenomenon resulting in the nonuniform pattern seen in their Figures 4 and 5. This possibility could be excluded by replacing their clamp with a foam or fabric cradle suspended between 2 thin rods to facilitate acquisition of a set of images with minimal scatter and attenuation.

Another experimental issue that needs attention is the use of a 15% symmetric energy window. The digital correction methods currently applied to the energy signal from state-of-the-art detectors allow much greater flexibility in setting energy windows than was formerly possible. Given that no other scatter reduction techniques are applied, setting an energy window that is asymmetrically high relative to the photopeak has been shown to improve the primary-to-scatter ratio and, therefore, resolution. The presence of angular dependence in the scatter ratio opens the possibility that use of a narrow, symmetric energy window could result in angular dependence of the system resolution and, thereby, nonuniformity in the reconstructed images and the CCP curves.

Regarding analytic errors, among a wide array of possibilities are some subtle pitfalls associated with CCP curves. Our own experience (3) has shown that artifactual nonuniformity can occur when CCP curves are developed by plotting the single value of the maximum pixel found along each individual search radius. Under certain conditions depending on the relationship between the exact physical position of the phantom in 3-dimensional space and the centers of the voxels in the reconstruction data matrix, this alignment factor can result in significant cyclic variations (essentially a Moiré effect) in the values of the maximum pixels extracted for the CCP curves and provides another possible explanation for the nonuniformity in the CCP curves presented by Liu et al. (1). One simple solution is to plot the maximum plus the sum of its 2 nearest radial neighbors, introducing a smoothing effect that will minimize the WA. The work of Liu et al. used the WL-CQ program (Eclipse Systems), which was described as using "maximal pixel values" to develop the CCP.

It is important to realize that this type of simplistic, thin-walled phantom is a very rigorous testing device and we should be careful about extrapolating any test results obtained with it to have immediate clinical implications. Every commercial SPECT system in clinical use today introduces its own particular forms of "distortion" in application to the acquisition, reconstruction, and presentation of 3-dimensional images. However, these systems can still have utility and efficacy in clinical application so long as the users are aware of these characteristics and are willing to develop and maintain techniques to recognize and "read around" these artifacts (4). Some of the measures that have been proposed to minimize artifacts (attenuation correction, elliptical orbits, and prone imaging, to mention a few) have not been proven to consistently increase the accuracy and reliability of SPECT cardiac studies.

Taken at face value, the single set of patient images shown in the article of Liu et al. (1) (their Fig. 1) implies that false-positive clinical results can primarily be attributed to the use of 180° orbits in performing myocardial perfusion studies. We cannot objectively evaluate this conclusion, however, until the WAs in the CCP curves shown there are fully explained. Other clinical investigations have shown that equally deleterious effects result from the poor resolution and scatter environments encountered under nominal clinical imaging conditions, especially when imaging large patients using a 360° orbit. What concerns us more than the issue of orbits is the ongoing failure to accurately identify all the

fundamental problems associated with rotational SPECT contributing to the unacceptably high incidence of false-positive studies.

The field of nuclear cardiology has experienced significant frustration and more than a few credibility issues stemming from the inherent variability in the anatomy and physiology of the human cardiovascular system as it interacts with the characteristics of rotational SPECT imaging systems to create artifacts. We have similar concerns with regard to the article by Blagosklonov et al. (2), describing "motionlike artifacts" in rotational SPECT studies. We disagree with the conclusion of those authors and propose that poststress, positionally dependent cardiac volume changes cause inconsistencies in the SPECT data that are much more problematic in the manner in which they temporally and spatially interact with sequential rotational SPECT image acquisition to create artifacts.

Rather than the orbital issues discussed in the article by Liu et al. (1) or rapid early ²⁰¹Tl washout as postulated in the article by Blagosklonov et al. (2), cardiac volume variability, which occurs after stress and after an acute transition from an upright to a supine position, is a more likely explanation for the compromised specificity and reproducibility encountered in rotational SPECT imaging. With regard to the clinical images shown in Figure 1 of Liu et al. (1), the 360° data were most likely taken over a longer interval than were the 180° data and therefore were less subject to the acute changes in cardiac volume that might have occurred immediately after the healthy volunteer was placed supine. This could be an alternative explanation for the artifact observed in the 180° data of their Figure 1.

Keep in mind that myocardial perfusion imaging primarily is a diagnostic modality that uses individual patients as their own standard. In other words, we are interested in comparing patients studied under stress conditions with the same patients studied at rest. The most salient fact apparent from the article of Liu et al. (1) is the technical importance of performing reproducible stress/rest imaging sequences on the same patient, using the same patient location and orientation and the same camera orbit for acquisition of both datasets, thereby minimizing systematically induced variables. The point that needs to be emphasized is that, whatever the artifactual characteristics of a given imaging system, the clinical efficacy of that system will largely depend on the user's ability to reproduce or eliminate those artifacts in successive image-acquisition sessions, thereby ensuring diagnostic comparability and accuracy. Far more significant advantages would be gained by such simple and expedient measures as marking patients with a laser positioning device to ensure reproducible positioning, using breast binding on female patients, and achieving physiologic equilibrium by having patients lie down for 15 min before initiation of rotational SPECT acquisitions.

The field of nuclear cardiology is currently at an impasse because it is relegated almost exclusively to the use of rotational SPECT imaging devices, which are dependent on moving detector systems for imaging the heart. The heart is itself a dynamically changing object in terms of both its size and its position. To a limited extent, temporal changes in patient position are correctable with software but changes in the size of the heart with time probably are not. Under these circumstances, one would expect some fundamental limitations to the accuracy and reproducibility of the results achievable by any system that acquires image data sequentially in time and immediately after the patient lies down. Whatever imaging methodology and clinical protocol is used, however, requisite technical measures must be taken to maximize statistical accuracy and ensure adequate image reproducibility.

One feasible design approach in this application is embodied in a multipinhole system based on arrays of stationary detectors that produce simultaneous stress/rest images within a single data-acquisition session (3). This type of simultaneous imaging system eliminates inconsistencies within the image dataset caused by temporal changes that occur between images or imaging sessions. The work of Liu et al. (1) has indicated that trade-offs between resolution, cost, and performance can result in a functional design for a multidetector, multiview system that does not need to acquire data from a full 360° subtended angle surrounding the patient. A primary benefit of this approach is an order-of-magnitude improvement in the statistical significance and quality of the gated images produced, and a direct result of the improvement in statistics is the ability to perform simultaneous stress/rest ²⁰¹Tl/^{99m}Tc perfusion imaging (5). Our experience is that this is the key to improved clinical specificity and reproducibility, which could open the door to the next level in the future practice of nuclear cardiology.

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Cardiac SPECT: 360° Circular Acquisition May Resolve Defects of 180° Data

TO THE EDITOR: We read with interest the article by Liu et al. in the August 2002 issue of the *Journal* (1). To reiterate, SPECT images acquired with a 180° orbit may have significant erroneous inhomogeneity and overestimate defect size if the target object is off the center of the orbit. We present 2 cases of patients who recently underwent 180° acquisitions that led to false-positive findings for the anteroseptal wall of the left ventricle.

Our routine procedure for dual-isotope (rest ²⁰¹Tl and stress ^{99m}Tc-tetrofosmin) cardiac gated SPECT uses a 3-head gamma camera (Prism; Picker) to acquire 360° SPECT data; however, following the guidelines of the American Society of Nuclear Cardiology (2), we use a circular orbit and an anterior 180° of SPECT acquired data to process SPECT images. We frequently find a small area of decreased uptake in the anteroseptal or inferolateral wall in the short axis of the SPECT image. This finding occurs on both ²⁰¹Tl and ^{99m}Tc-tetrofosmin SPECT images. Here are 2 recent examples.

The first case was a 41-y-old man with a history of alcohol abuse 4–5 y ago who complained of atypical chest pain with and without exertion over the past 2 mo. He was referred for dipyridamole ^{99m}Tc-tetrofosmin and rest ²⁰¹Tl-chloride cardiac gated SPECT. Moderate enlargement of the left ventricle and slightly decreased activity in the anteroseptal area were seen in the short axes of both the ^{99m}Tc-tetrofosmin and the ²⁰¹Tl cardiac SPECT images. These SPECT acquisitions depended on 180° data. In SPECT images obtained using 360° data, the area of decreased uptake in the anteroseptal wall was no longer seen in either the ^{99m}Tc-tetrofosmin or the ²⁰¹Tl short axes. Left ventricular ejection fraction was 51% (normal ejection fraction is ≥50%).

The second case was a 59-y-old man with prostate cancer who was scheduled for radical perineal prostatectomy and was referred for dipyridamole ^{99m}Tc-tetrofosmin and rest ²⁰¹Tl-chloride cardiac gated SPECT for presurgical evaluation. The patient had a history of hypertension and coronary artery disease and had undergone angioplasty in the past. Imaging was performed using a 3-head gamma camera. Slightly decreased uptake in the anteroseptal wall was more apparent in the short-axis ²⁰¹Tl SPECT images than in the ^{99m}Tc-tetrofosmin SPECT images. On SPECT images obtained using 360° data, the hypoperfusion in the anteroseptal wall had almost disappeared. Gated SPECT showed normal wall motion of both ventricles. Left ventricular ejection fraction was 61%.

Our 2 cases concur with reports that SPECT images acquired with a 360° orbit may provide more accurate quantitative information. Inhomogeneity may occur with 180° acquired SPECT data. The use of a circular orbit and an anterior 180° (right anterior oblique to left posterior oblique) acquisition orbit has been standardized by the American Society of Nuclear Cardiology (2); however, because 360° data are available from our 3-head camera, our policy is to use such data whenever an area of hypoperfusion in the anteroseptal wall is suspected. SPECT images acquired with a 360° orbit may provide more accurate quantitative information and are less likely to be affected by artifacts.

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REPLY: We appreciate the opportunity to address some of the issues raised by Dennis Kirch and colleagues regarding our original article (1). The major concern mentioned in the Kirch letter was the “wavy” circumferential count profiles of the “normal” phantom in the center position using 180° and 360° acquisition orbits. The focus of our study was to investigate in a systematic manner the effects of 180° image acquisition and phantom position on image uniformity. Although we were also intrigued by the presence of the wavy artifact, we believe that it did not affect the validity of our findings and conclusions, since all images were

acquired using the same SPECT camera. Furthermore, as mentioned in our article, we also performed complementary experiments using a different triple-head SPECT camera. The findings using this different camera were entirely consistent with those presented in our article (1).

We certainly agree with Kirch's comments that SPECT imaging is a complex process, in which mechanic deficiencies may contribute to image distortion.

Regarding systematic error, although the tasks specifically suggested by Kirch were not executed in our study, the SPECT camera has been maintained and serviced scrupulously according to the vendor's specification. Center-of-rotation offset is checked quarterly. Quality control for detector uniformity and image resolution is performed by technologists daily.

Regarding experimental error, for quantification of the SPECT studies, the basal portions of the phantom close to the wood frame were excluded to minimize potential scatter and attenuation from the wood. The wavy pattern was present in all apical, midventricular, and basal slices. The fact that the pattern was slightly greater when the phantom was angled was in accordance with our assumption. Thus, we believe that the wavy artifact was most likely caused by imperfect positioning of the phantom and deviation from the centerline. We agree that replacing the wood frame with a paper or fabric cradle and positioning the phantom with a laser device might be helpful to eliminate the potential effect of scattering material. Although, theoretically, using an asymmetric ^{99m}Tc energy window may improve the primary-to-scatter ratio as suggested by Kirch, Devous et al. showed that in practice this step did not significantly improve image quality (2).

Regarding analytic error, the circumferential count profile generated by the WL-CQ software (Eclipse Systems), not being based simply on a single maximal pixel value, was contrary to what was assumed by Kirch. Instead, a bilinear interpolation scheme of averaging 4 nearest radial and circumferential neighbors of the maximal pixel was incorporated into our data sampling. Thus, a smoothing strategy similar to that Kirch suggested had been adapted into our count profile generation, although it was not described in detail in our previous publications (3,4).

We also appreciate the comments of Wei-Jen Shih and colleague regarding differences in clinical image uniformity associated with 180° and 360° acquisitions. Clinical SPECT images acquired with a 360° orbit may provide more accurate quantitative information, whereas nonhomogeneity may occur with 180° acquired SPECT data. These clinical observations support our findings of the phantom study. We have also observed the same phenomenon reported in our patient population. In fact, these observations prompted our conducting of this phantom study. It is important to realize that, because of differences in patient body habitus, artifacts due to 180° acquisition may be more or less prominent in individual patients.

Ultimately, we would like to emphasize that the purpose of this phantom study was to answer a fundamental question: Does 360° full-image acquisition improve quantitative SPECT accuracy in terms of count profile homogeneity and myocardial perfusion defect size? Our results suggest that central positioning of the target imaged and 360° acquisition are important parameters for optimal image quality. Although the phantom we used appears to be "simplistic," it allowed us to investigate a single variable in isolation. Increased nonhomogeneity and inconsistent defect size quantification appear to be caused primarily by the depth-dependent point-spread function of SPECT imaging systems. Nonhomo-

geneity and inconsistent quantification are suboptimal when a 180° imaging orbit is used.

As Kirch mentioned, special effort in positioning patients for clinical SPECT imaging is needed to ensure diagnostic comparability and reproducibility. On the basis of our clinical observation and phantom study, we have modified our practice to perform only 360° image acquisitions. We find that this approach improves image uniformity.

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Prognosis of Primary Osteosarcoma

TO THE EDITOR: We read with interest the article by Franzus et al. (1) dealing with the prognostic significance of ^{18}F -FDG and ^{99m}Tc -methylene diphosphonate (MDP) uptake in primary osteosarcoma. The authors examined 29 patients and semiquantitatively measured ^{18}F -FDG and ^{99m}Tc -MDP uptake (average and maximum tumor-to-nontumor ratios [T/NT_{av} and T/NT_{max} , respectively]) using PET and bone scintigraphy at the time of diagnosis. We congratulate the authors on their excellent study. It showed that initial ^{18}F -FDG T/NT_{max} values clearly discriminated between osteosarcoma patients with a high probability of overall and event-free survival and osteosarcoma patients with a poor prognosis. The authors did not observe a correlation between ^{99m}Tc -MDP uptake and prognosis. These results agreed with the reports of another group (2), which could not find any significant relationship at any time between absolute radiopharmaceutical activity within the primary lesion and either disease progression or patient survival.

The evaluation of other parameters, such as quantification of perfusion or venous blood pool (vascular and soft-tissue factors), in 3-phase bone scintigraphy could have led to a more specific conclusion about prognosis. Former studies have already shown that the vascular factor is an important predictor of therapeutic response (3,4). A decrease in the tumor-to-blood flow ratio and extension were the most notable findings in responders to chemotherapy.

The study showed a significant correlation between ^{18}F -FDG T/NT_{max} and prognostic outcome. However, it is unfortunate that

transmission scanning was not performed in all cases and that consecutive standardized uptake values (SUVs) could not be evaluated sufficiently. This might have provided a prognostically valuable cutoff for SUVs.

On the other hand, the comparison of data using tumor-to-nontumor ratios and data using SUVs is limited because tumor-to-nontumor ratios are a less quantitative measurement of tumor ^{18}F -FDG metabolism than are SUVs.

In conclusion, we expect that assessment of all available parameters (perfusion, blood pool, mineralization, and glucose consumption) would give the most reliable information for further patient management.

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REPLY: We appreciate the comments on our article (1) and the opportunity to respond.

We agree that changes in blood flow between a pretherapeutic and a posttherapeutic 3-phase bone scan correlate with the response of an osteosarcoma to chemotherapy, as has been demonstrated by several authors. Recent studies suggest that ^{18}F -FDG PET may also be useful for the monitoring of chemotherapy response in osteosarcomas (2,3). Response to neoadjuvant chemotherapy is well known to be an important prognostic parameter in osteosarcoma (4). However, response is a treatment-related variable and not available at initial patient presentation. Therefore, the aim of our study was to evaluate the prognostic significance of ^{18}F -FDG and $^{99\text{m}}\text{Tc}$ -methylene diphosphonate uptake at the time of diagnosis. In our retrospective analysis, initial ^{18}F -FDG uptake

measured by maximum tumor-to-nontumor ratio clearly discriminated between good and poor survival. As the authors of the letter mentioned, it would also be interesting to analyze the prognostic value of tumor perfusion before chemotherapy. To the best of our knowledge, this has not yet been evaluated in osteosarcomas.

For technical reasons, no transmission scans were obtained in the first patients examined by ^{18}F -FDG PET. However, attenuation should not play a major role in these young patients, as nearly all primary osteosarcomas were localized in the extremities (with the exception of one pelvic osteosarcoma). Therefore, we could not determine a cutoff standardized uptake value (SUV) between good and poor survival. A recent retrospective study suggested that the ^{18}F -FDG maximum SUV of various sarcomas determined by PET might be an independent predictor of disease progression and survival (5). Therefore, one could hypothesize that ^{18}F -FDG uptake as measured by maximum SUV might also be used to predict prognosis in osteosarcoma. Prospective studies to evaluate this hypothesis are warranted. Furthermore, a possible correlation between ^{18}F -FDG uptake and other well-defined prognostic factors needs to be assessed.

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