Myocardial Viability Studies Using Fluorine-18-FDG SPECT: A Comparison with Fluorine-18-FDG PET

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Multidetector SPECT systems equipped with a high-energy, or 511-keV collimator, have been proposed to offer a less expensive alternative to PET in myocardial viability studies with [18F]FDG. The objectives of this investigation included: (a) measuring the physical imaging characteristics of SPECT systems equipped with either a high-energy general-purpose collimator (HE), or the dedicated 511-keV collimator (UH), when imaging 511-keV photons, and comparing them with conventional FDG PET; and (b) directly and quantitatively comparing the diagnostic accuracy of SPECT, with either an UH or HE collimator, to that of PET in myocardial viability studies using 18F-FDG. **Methods:** Physical imaging characteristics of SPECT and PET were measured and compared. Both SPECT and PET studies were performed in two groups of 18 patients each, with Group I using HE SPECT and Group II using UH SPECT. Myocardial perfusion studies were also performed using 82Rb PET at rest and during dipyridamole stress to identify areas of persistent hypoperfusion. For each myocardial region with a persistent perfusion defect, a perfusion-metabolism match or mismatch pattern was established independently, based on the results of 18F-FDG SPECT as well as PET. **Results:** PET is superior to SPECT in all physical imaging characteristics, particularly in sensitivity and contrast resolution. PET had a sensitivity 40–80 times higher than that of SPECT, and its contrast resolution was 40–100% better than SPECT. Between FDG-SPECT using an HE collimator and that using a 511-keV collimator, the latter showed marked reduction in septal penetration (from 56% to 38%), improvement in spatial resolution (from 17 mm to 11 mm FWHM) as well as contrast resolution (from 34% to 45%), while suffering reduced system sensitivity (from 75 to 34 cpm/μCi). Patient studies demonstrated that although FDG-SPECT, using a HE or UH collimator, provided concordant viability information as FDG PET in a large majority of myocardial segments with persistent perfusion defects (88% and 90%, respectively), there is an excellent statistical agreement (κ = 0.736) between SPECT with UH collimator and PET, while the agreement between SPECT using HE collimator and PET are moderate (κ = 0.413). **Conclusion:** Despite its markedly inferior physical imaging characteristics compared with PET, SPECT with the dedicated 511-keV collimator offers a low-cost, practical alternative to PET in studying myocardial viability using [18F]FDG. SPECT systems with a high-energy, general-purpose collimator, on the other hand, are inadequate in such studies.

Key Words: fluorine-18-FDG; SPECT; myocardial viability

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PET imaging of 18F-deoxyglucose ([18F]FDG) myocardial uptake has become an established technique for the detection of residual viability in hypoperfused, dysfunctional myocardial segments (1) in CAD patients. Regional uptake of 18F-FDG, obtained by PET imaging, provides important information about myocardial viability that can directly affect the clinical decision-making process. The widespread clinical use of this technique, however, is limited by the high costs of the PET system and the finite number of patient studies that can be

performed in existing PET centers. The ability to study FDG myocardial uptake using SPECT cameras, which are widely available and much less expensive, may be a practical alternative. Previous reports demonstrated that single- (2), double-(3,4) and triple-headed camera systems (5), either with a conventional high-energy collimator (5) or a collimator specifically designed for 511-keV photons (2,3) can be used to image FDG myocardial uptake. It has been suggested that FDG-SPECT images provided diagnostic information comparable to PET regarding myocardial viability (3,5).

It is known that PET offers imaging characteristics substantially superior to SPECT, resulting in higher diagnostic accuracy of PET myocardial perfusion studies as compared to 201Tl-SPECT (6). SPECT imaging of 511-keV photons suffers in particular from the large amount of septal penetration. Special collimators have been designed for 511-keV SPECT imaging, with increased septal length or thickness or both, to reduce septal penetration but often at the expense of reduced camera sensitivity. In fact, the clinical implications of these different and often conflicting factors in imaging characteristics for the assessment of myocardial viability have not been fully evaluated. It is the purpose of this investigation to first measure and compare the physical imaging characteristics of SPECT with the conventional high-energy general-purpose collimator, SPECT with a collimator specially designed for 511-keV imaging and PET and, second, to prospectively and quantitatively compare the clinical results of FDG-SPECT to FDG-PET in myocardial viability studies in the same patients.

MATERIALS AND METHODS

Imaging Equipment and Physical Measurements

The SPECT system used in this investigation was a Triad-XLT (Trionix Research Laboratory, Twinsburg, OH) triple-headed camera. Two types of collimators were employed for the FDG-SPECT studies: the conventional high-energy, general-purpose, parallel-hole collimator (HE) rated at 400-keV and the 511-keV collimator (UH) specially designed for imaging with positron emitters. Special lead side shielding was added to both types of collimators to prevent photons from entering the side of the camera. The PET camera used in the comparison was a Posicam 6.5 whole-body PET system (Positron Corp, Houston, TX) with an axial field of view of 11.5 cm and in-plane field of view of 43.5 cm in diameter.

One of the most important issues in 511-keV SPECT is septal penetration. The amount of septal penetration for both the HE and UH collimators was determined from the image data of a 15-cm long, 1.3-mm diameter 68Ge line source, positioned 10 cm away from and parallel to the surface of the collimator. In order to account for the directionality of the septa in a collimator, images were acquired with the line source at four different orientations 45° apart. Each acquisition had at least 150 million counts. The final line spread function was obtained by averaging the central, transverse count profiles of all four images. A Gaussian function was then fitted to the primary portion of the line spread function
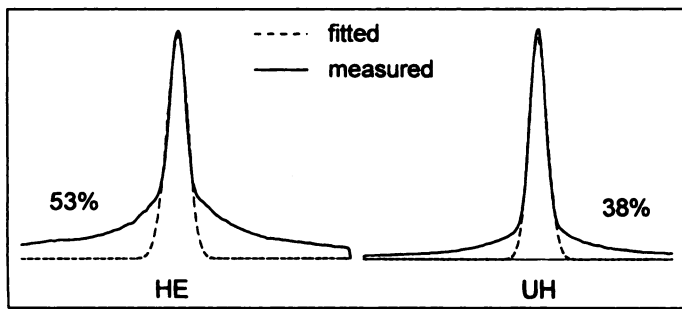
FIGURE 1. The line spread functions of the SPECT system with the HE collimator and UH collimator. By fitting a Gaussian function (dotted lines) to the line spread function (solid lines), septal penetration was determined as 53% for the HE collimator and 38% for the UH collimator.

(Fig. 1). The amount of septal penetration was given by the counts represented by the area between the fitted Gaussian curve and the line spread function, as a fraction of the total counts represented by the area under the line spread function.

The system sensitivity of Triad-XLT at 511-keV with both HE and UH collimator was measured for each of the three detector heads using a 10-cm diameter ^{68}Ga disk source positioned 10 cm from the collimator surface, according to the NEMA recommendations (7). For comparison, the system sensitivity at 140-keV with the low-energy, general-purpose collimator (LE) was measured using a ^{99m}Tc source in the same fashion.

The volume sensitivities of SPECT and PET were also measured. A cylindrical phantom, 18 cm long and 20 cm in diameter, was filled with a ^{68}Ga solution at a concentration of approximately 0.15 μCi/ml. In SPECT imaging, with either an HE or UH collimator, 90 projection images were acquired on a 64 × 64 matrix at 4° intervals and for 60 sec per step. The same phantom was also imaged on the PET system for a total of 30 million counts. A tomographic reconstruction was performed with attenuation correction and corrections for physical decay and using a ramp filter with cutoff at the Nyquist frequency. An average count per pixel value was obtained by drawing a 5-cm diameter circular ROI at the center of the middle slice of the reconstructed phantom image set. Both before and after each scan, the activity concentration was obtained and decay corrected by taking a 10-ml sample of the ^{68}Ga solution from the phantom and measuring its activity in a calibrated dose calibrator. The volume sensitivity was then calculated as the ratio between the count per pixel value and the actual activity concentration for both SPECT and PET systems.

The measurement of tomographic spatial resolution was made with the use of a ^{68}Ga line source secured at the center of the 20-cm diameter, water-filled cylindrical phantom. The phantom was positioned at the center of the imaging field of view with its axis parallel to the long axis of the patient bed. The measurement was performed on the SPECT system equipped with either the HE or UH collimator as well as on the PET system. An acquisition matrix size of 256 × 256 was selected, resulting in 1.78 × 1.78 mm² pixel size in SPECT and 1.7 × 1.7 mm² pixel size in PET. The tomographic images of the line source were reconstructed using a ramp filter with cutoff at the Nyquist frequency.

The contrast resolution of a simulated myocardial defect, 2 × 2 × 1 cm³ in size, was determined for SPECT with the HE collimator, SPECT with the UH collimator and PET. The simulated myocardial defect was placed in a Jaszczak cardiac insert, which was in turn positioned in a waterfilled thoracic phantom (Data Spectrum Corp., Chapel Hill, NC). A count profile across the defect was obtained and the contrast resolution was calculated as a percent decrease of the counts at the center of the defect relative to the rest of the profile. Tomographic images were reconstructed using the routine clinical cardiac parameters.

Patient Studies

Thirty-six randomly selected patients were included. All patients were referred for PET study for the assessment of myocardial viability and thus were not dependent on the additional FDG-SPECT study for clinical information. An information sheet concerning the investigation approved by the institutional review board was provided to the patients for obtaining informed consent. In each patient, a ^{82}Rb PET myocardial perfusion study was first performed at rest and stress. Then an FDG-PET study was performed immediately, followed by FDG-SPECT imaging on a SPECT system nearby, usually within 5 min, in order to minimize the effects of physical decay. The FDG-SPECT studies for the first 18 patients (Group I) were performed using the Triad-XLT system equipped with the HE collimator, while the second 18 patients (Group II) were scanned with the UH collimator.

Rubidium-82 and FDG-PET Imaging

Both ^{82}Rb and FDG PET studies were performed with the of 256 × 256 matrix size. Twenty-one contiguous transverse slices, each with a thickness of 5.125 mm, were obtained covering an axial field of view of about 11 cm. Localization of the heart was accomplished by a 2-min pilot scan of the chest after intravenous administration of 740 MBq (20 mCi) of ^{82}Rb. For attenuation correction, a 111-MBq (3 mCi) ^{68}Ge line source, rotating around the patient, was used to obtain the transmission images. Tomographic reconstruction was performed with a Positron Data Acquisition system using backprojection with a Butterworth filter of order 5 and a cutoff frequency of 0.04 cycle/mm.

A resting ^{82}Rb image of the heart was first obtained 65 sec after infusion of 2.22 GBq (60 mCi) of ^{82}Rb, followed by a stress scan using the dipyridamole and handgrip protocol (8). The FDG study was performed after the ^{82}Rb procedure and the same transmission image was used for attenuation correction in both studies. One hour after oral administration of 50 g of dextrose, 74–222 MBq (2–6 mCi) of ^{18}F-FDG was administered intravenously, and a 20-min acquisition was performed 45 min after injection. In each patient, plasma glucose level was measured. Insulin was given to diabetic patients with blood glucose level above 120 mg/dl, repeatedly when necessary to facilitate myocardial uptake of FDG. Positioning markers were placed identically to those used for the transmission and ^{82}Rb perfusion studies in order to prevent artifacts caused by patient motion between transmission and emission scans (9). In addition, possible misalignment between transmission and emission scans were visually inspected and, once identified, corrected by interactively shifting the image matrices.

FDG-SPECT Imaging

Imaging began immediately after the completion of the FDG PET scan. A camera orbit was selected to achieve optimal detector-patient proximity. There were 30 stops per camera head with 30 sec per stop, making a total of 90 projection images. Projection data were acquired on a 64 × 64 matrix for 32 slices of 7.12 mm each. The total counts of a study ranged from 0.3 to 3 million.

Tomographic reconstructions were performed using filtered backprojection on a SPARC Station 10 (Sun Microsystems, Mountain View, CA) with a Hamming filter and a cutoff frequency of 0.5 cycle/cm, the same as used in thallium imaging. The original slices of PET or SPECT images were then transferred to a Micro VAX 3.5 computer (Digital Equipment Corp., Maynard, MA) where they were reoriented to the cardiac axis to generate three orthogonal tomographic image sets of the heart.

Image Quality Score

In each patient, the SPECT image quality was visually compared to that of PET and graded subjectively using an image quality score (IQS) of 1 through 4 according the following criteria: 4 = SPECT image quality is almost as good as that of PET; 3 = SPECT image quality is somewhat inferior to that of PET but still exhibits good delineation between the myocardium and ventricular cavity; 2 = SPECT image quality is markedly inferior to that of PET but acceptable for interpretation; 1 = barely interpretable. The average IQS score for all patients in Group I was calculated and compared with that for Group II.

Image Interpretation

The left ventricular myocardium was divided into eight segments, or 24 regions (8). Seven segments consisted of the anterior, anterolateral, anteroseptal, lateral, inferolateral, inferior and inferoseptal segments. These seven major segments were further divided into proximal, middle and distal regions for a total of 21 regions. The remaining three regions consisted of midseptal, distal septal and apical regions, which represented the eighth segment.

All studies were interpreted in a semiquantitative fashion. Images were displayed slice by slice using the 5% or 10% color scales after being normalized to the maximum pixel counts of the entire heart. The perfusion status of each myocardial region was established by the [82]Rb PET images. Each myocardial region was classified as normal, or containing a reversible defect, or irreversible perfusion defect using the previously described criteria (8). Briefly speaking, a myocardial region was considered irreversibly hypoperfused if both normalized rest and stress perfusion images of the region showed an individual decrease in average count of more than 30%, or 35–40% in the case of apical or inferior regions, as compared to the regions with the highest count, and a difference of less than 15% in decrease between the rest and stress images.

The metabolic status of each myocardial region identified as irreversibly hypoperfused was further assessed using both FDG PET and SPECT images. The PET and SPECT studies were interpreted independently by two observers blinded to the result of the other modality.

FDG PET and SPECT images were interpreted in conjunction with [82]Rb perfusion images. Myocardial regions with the highest FDG counts (81–100%) were considered to have high glucose uptake. Regions with counts of 71–80%, compared to the regions with highest counts, were considered to have partial glucose uptake. Regions with decreased counts of 70% or less, compared to regions with highest counts, were considered to have decreased glucose uptake (8). Regions showing a reduced or partial FDG uptake and irreversible perfusion defect were considered as having the perfusion-metabolism match pattern characteristic of myocardial scar (Fig. 2A, B, C). Irreversibly hypoperfused regions with high FDG uptake were classified as having the perfusion-metabolism mismatch pattern characteristic of hibernating myocardium (Fig. 2D, E, F).

RESULTS

Measurement of Physical Imaging Characteristics

Septal penetration was 53% for the HE collimator and 38% for the UH collimator. The larger amount of septal penetration for the HE collimator was represented by the more prominent tails in the line spread function that extend beyond the detector field of view. The septal penetration figure for the HE collimator was in line with the 56% value reported by Martin et al. (3).

The system sensitivity of the Triad-XLT camera equipped with HE collimator was 160 cpm/μCi for 511 keV, while the sensitivity for the same camera with UH collimator was 55 cpm/μCi. Both figures are substantially lower than the system
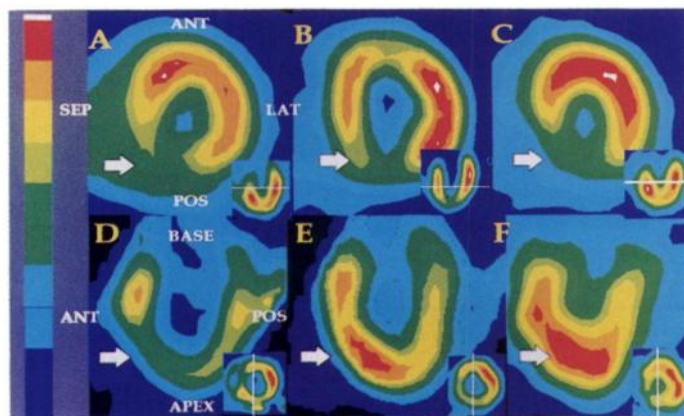
FIGURE 2. Top: (A) An [82]Rb PET study at rest demonstrated persistent perfusion defect in the inferoseptal and inferior regions (arrow). Reduced FDG uptake in these regions was shown by both (B) PET and (C) SPECT, characteristic of myocardial scar. Bottom: (D) Persistent perfusion defect in the distal-anterior and apical regions of the myocardium was shown in resting [82]Rb PET image. Both (E) PET and (F) SPECT ^{18}F-FDG studies showed high glucose metabolism in these regions, consistent with hibernating myocardium.

sensitivity of 338 cpm/μCi for the same camera equipped with the LE collimator for imaging 140-keV gamma rays. It should be noted, however, that the system sensitivities thus measured included a significant amount of septal penetration, while with 140-keV photons and the LE collimator the septal penetration is negligible (10). Excluding septal penetration, the system sensitivity for SPECT with HE collimator was 75 cpm/μCi, while that with UE collimator was 34 cpm/μCi.

When septal penetration was excluded, the volume sensitivity of SPECT with the HE collimator was 4.4 kcps/μCi/ml, less than 2.5% of the 180 kcps/μCi/ml sensitivity of PET, whereas SPECT with the UH collimator had a volume sensitivity of 2.25 kcps/μCi/ml, about 1.2% as compared to PET.

The tomographic spatial resolutions of SPECT with HE collimators and the UH collimator, along with the spatial resolution of PET were all measured using the same ^{68}Ga line source secured in a 20-cm diameter, water-filled cylinder. The spatial resolution, measured as FWHM, was 17 mm for SPECT with the HE collimator and 11 mm for SPECT with the UH collimator. They were both substantially inferior to the 6.5 mm FWHM of PET.

The contrast resolution of a 2 × 2 × 1 cm^3 simulated myocardial defect was 34% for SPECT with the HE collimator, and 45% for SPECT with the UH collimator. As a comparison, the contrast resolution for the PET system was 65%.

Clinical Studies

Image Quality Scores. The average IQS score for the 18 patients in Group I was 2.67 ± 1.13, while the average IQS score for the SPECT studies in Group II was 3.44 ± 0.78. The image quality of FDG-SPECT studies in Group II, measured by IQS scores, was significantly better than those in Group I (p < 0.015).

Diagnostic Accuracies. In the 18 patients in Group I (SPECT with the HE collimator), 198 myocardial regions were identified as having persistent perfusion defect by [82]Rb PET myocardial perfusion studies at rest and stress. Among these regions, FDG-SPECT provided concordant information about myocardial viability in 174 (88%) myocardial regions with that of PET (Table 1). In seven myocardial regions, SPECT showed a partial or reduced FDG uptake, while high FDG uptake was exhibited by PET. An example of such cases is given in the bottom row of Fig. 3. In this patient, the [82]Rb PET study

TABLE 1
Direct Comparison of FDG-SPECT Using HE and UH Collimators with FDG PET in Myocardial Viability Studies

	SPECT (HE/UH)	
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	Not viable	Viable
PET		
Not viable	163/121	17/12
Viable	7/6	11/37

TABLE 2
Sensitivity of SPECT (UH and HE)*

	Total	SPECT viable	SPECT nonviable	Sensitivity
SPECT (HE)	18	11	7	61%
SPECT (UH)	43	37	6	86%

*(p < 0.015)

indicated a persistent perfusion defect in the proximal region of the anterolateral wall (Fig. 3D). In this region, high FDG uptake was shown by PET (Fig. 3E) but the FDG-SPECT study showed reduced tracer uptake (Fig. 3F). In 17 regions, on the other hand, SPECT images showed high FDG uptake, whereas reduced uptake was indicated by PET. In the case given in the top row of Figure 3, an irreversible perfusion defect was found in the apical region by [82]Rb PET (Fig. 3A). PET showed a reduced regional FDG uptake in this region (Fig. 3B), while high FDG uptake was seen by SPECT (Fig. 3C). A Kappa test suggested that, in this patient population, the diagnostic results of FDG-SPECT and FDG PET were in relatively good agreement (κ = 0.413, p < 0.00001) (11). Similarly, in the 18 patients in Group II (SPECT with UH collimator), FDG-SPECT provided concordant information about myocardial viability in 158 (90%) of the 176 myocardial regions identified by [82]Rb PET as having persistent perfusion defects (Table 1). A Kappa test indicated that results of FDG-SPECT and PET were in excellent agreement (κ = 0.736, p < 0.00001). Although FDG-SPECT offered concordant viability information as FDG PET in a similar fraction of total myocardial regions using either the HE collimator (88%) or the UH collimator (90%), a chi-square test showed that the results of FDG-SPECT with the UH collimator are in significantly better agreement with FDG PET than FDG-SPECT using the HE collimator (χ^2 = 8.044, p < 0.005).

Using the results of FDG PET as the gold standard, FDG-SPECT equipped with the dedicated 511-keV collimator had a sensitivity of 86% (37 of 43) in detecting viable myocardial regions, which is significantly better than the sensitivity of 61% (11 of 18) when the conventional high-energy collimator was used (p < 0.015) (Table 2). On the other hand, FDG-SPECT,
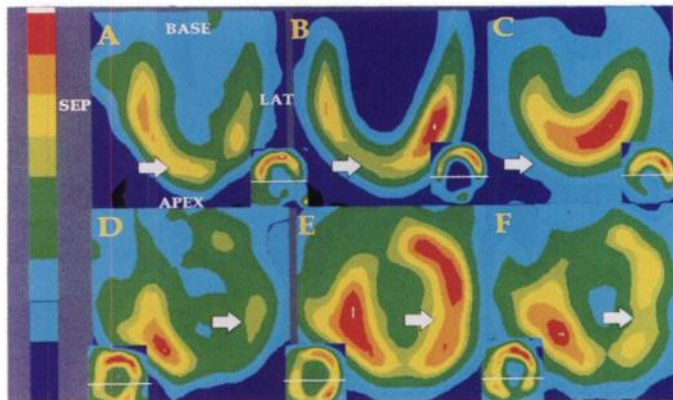
FIGURE 3. Top: An example where FDG-SPECT suggested viable myocardium while FDG-PET indicated myocardial scar. (A) Rubidium-82 PET showed an apical perfusion defect (arrow). Reduced FDG uptake was shown by (B) PET, while (C) SPECT showed normal FDG uptake. Bottom: Negative FDG-SPECT and positive FDG-PET for myocardial viability. (D) A persistent perfusion defect (arror) was shown by [82]Rb PET. While the (E) FDG-PET image showed normal FDG uptake, the (F) FDG-SPECT study demonstrated reduced FDG uptake.

with both the HE and UH collimators, had the same specificity of 91% in identifying nonviable myocardial regions.

DISCUSSION

In this investigation, we have shown that 511-keV SPECT using either a high-energy collimator or the dedicated 511-keV collimator is substantially inferior to PET in all the imaging characteristics. The volume sensitivities of SPECT ranges from 1.5% to 2.5% of the sensitivity of PET. The $\frac{3}{8}$-inch NaI (Tl) crystal in the SPECT camera used in this investigation is better suited for conventional studies at lower photon energies, such as those of ^{201}Tl and ^{99m}Tc, but suffers from low detection efficiency when imaging 511-keV annihilation photons. Other investigators used cameras with a $\frac{1}{2}$-inch crystal (2) for its higher detection efficiency. The low sensitivity of 511-keV SPECT can sometimes be compensated for by an increase in the dose given. In fact, other investigators used higher doses of 10 mCi FDG (3–5). Logistical constraints, however, frequently made it difficult to give a larger dose, especially for patients with hyperglycemia where repeated measurement of plasma glucose levels and administration of insulin were needed before starting the study.

The tomographic spatial resolutions provided by 511-keV SPECT are also poorer than that of PET. The SPECT spatial resolution was substantially improved by using the UH collimator instead of the HE collimator. It should be pointed out, however, that the spatial resolutions were measured from images reconstructed using a ramp filter with cutoff at the Nyquist frequency. In the clinical myocardial studies, on the other hand, additional low-pass filters used in the reconstruction process, reduce spatial resolution to about 15 mm FWHM for PET and 16 mm FWHM for SPECT with UH collimator.

It is of practical interest to compare the physical performance of SPECT systems equipped with the HE collimator, currently available in many laboratories, with those using the UH collimator specially designed for 511-keV imaging. The UH collimator used in this investigation was designed to maximize spatial resolution and reduce septal penetration while maintaining adequate sensitivity. As a result, the tomographic spatial resolution was improved to 11 mm FWHM as compared to 17 mm provided by the HE collimator, while the counting rate sensitivity was reduced by nearly 50%. The fact that FDG-SPECT studies acquired using the UH collimator were generally of better image quality than those using the HE collimator demonstrated that, in the application of FDG myocardial viability study, the trade-off between reducing septal penetration and maintaining adequate sensitivity has been largely successful.

Whether FDG-SPECT can become a viable alternative to PET in myocardial viability studies, or possibly other imaging procedures with positron emitters, and whether the current design of 511-keV collimators provided the optimal tradeoff between sensitivity and spatial resolution, the answer to these questions can only be found through clinical investigations.

The fact that FDG-SPECT provided myocardial viability information concordant with FDG PET despite its generally inferior physical imaging characteristics can largely be attributed to the nature of myocardial viability studies using FDG. The establishment of a metabolic status usually involves a relatively large area of the myocardium, making the poorer spatial resolution of 511-keV SPECT less detrimental. Furthermore, a previous investigation (*12*) showed that 12.6% of all the myocardial segments with persistent perfusion defect had an FDG uptake level between 70–80% compared to the regions of the highest FDG uptake, a partial FDG uptake indicative of myocardial scar component. Only among these myocardial segments, the relatively lower contrast resolution of 511-keV SPECT may have caused differences in viability results. In other applications such as neurological and oncological imaging, where smaller differences in uptake involving a smaller region needs to be detected, the poorer physical imaging characteristics of 511-keV SPECT may have a larger impact on the diagnostic accuracies.

There are several factors that could have caused the positive FDG-SPECT and negative FDG PET for myocardial viability. One is the lower contrast resolution of FDG-SPECT, which could overestimate the FDG uptake of a myocardial segment compared to its neighboring normal segments and cause a false positive reading. Another factor is attenuation artifact. The underestimation of FDG uptake in the posterior-inferior region can cause an overestimation of relative FDG uptake in the anterior, apical region, creating a false positive for myocardial viability. Similarly, attenuation artifact, along with the poor image quality in some SPECT studies, has probably caused the small number of segments with positive PET and negative SPECT for viability.

The lack of adequate attenuation correction remains a primary concern with SPECT. The problems caused by the soft-tissue attenuation, although lessened in 511-keV SPECT imaging compared to ^{201}Tl or ^{99m}Tc due to the higher energy of the annihilation photons, remain unsolved. We chose not to report our results using the uniform attenuation correction method available in the SPECT system. Our past experiences suggested that the large degree of density heterogeneity in the chest makes this correction technique often ineffective and frequently misleading. Attenuation artifact was suspected to be the culprit in several patients where SPECT and PET provided different information about myocardial viability. For example, in the patient shown in the bottom of Figure 3, the lack of attenuation correction in SPECT had possibly caused the apparent high FDG uptake in the apical and other distal regions of the left ventricle which, coupled with the lower contrast resolution in SPECT, could have obscured the region with reduced FDG uptake that was shown in the PET image.

CONCLUSION

This investigation has demonstrated, by directly comparing SPECT and PET results in the same patients, that despite their markedly inferior physical imaging characteristics compared to PET, triple-headed SPECT systems equipped with the dedicated 511-keV collimator generated adequate images from which equivalent information about myocardial viability can be obtained. It, therefore, can be used clinically as a practical alternative to PET in myocardial viability studies using FDG. We have also shown that with the conventional high-energy general-purpose collimator, FDG-SPECT can misclassify a significant number of myocardial regions that were identified as viable by FDG PET.

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