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Comparison Between Using (Technetium-99m (^{99m}Tc) → SPECT Imaging and (Fluorine-18 (^{18}F) → PET Imaging

Review Article

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In nuclear medicine, the main widely used radioisotopes for imaging are:

1. Technetium-99m (^{99m}Tc) for SPECT (Single Photon Emission Computed Tomography)
2. Fluorine-18 (^{18}F) for PET (Positron Emission Tomography).

Below is a comparative analysis of their roles in nuclear medicine:

Figure 1: SPECT Scan and PET Scan

Imaging modality & Physics

Feature	Technetium-99m (^{99m}Tc) – SPECT	Fluorine-18 (^{18}F) – PET
Decay mode	Gamma emission (140 keV)	Positron emission (β□, 0.64 MeV)
Detection	Uses a collimator for detecting gamma photons	Detects annihilation photons (511 keV) from positron decay
Resolution	Moderate (6–10 mm)	Higher (~3–5 mm)
Sensitivity	Lower than PET	Higher sensitivity
Attenuation	More susceptible to attenuation	Less attenuation due to higher energy
Sensitivity	Lower than PET	Higher sensitivity
Attenuation	More susceptible to attenuation	Less attenuation due to higher energy

Table 1. Comparison of Features between Technetium-^{99m}Tc-SPECT and Fluorine 18 ^{18}F-PET

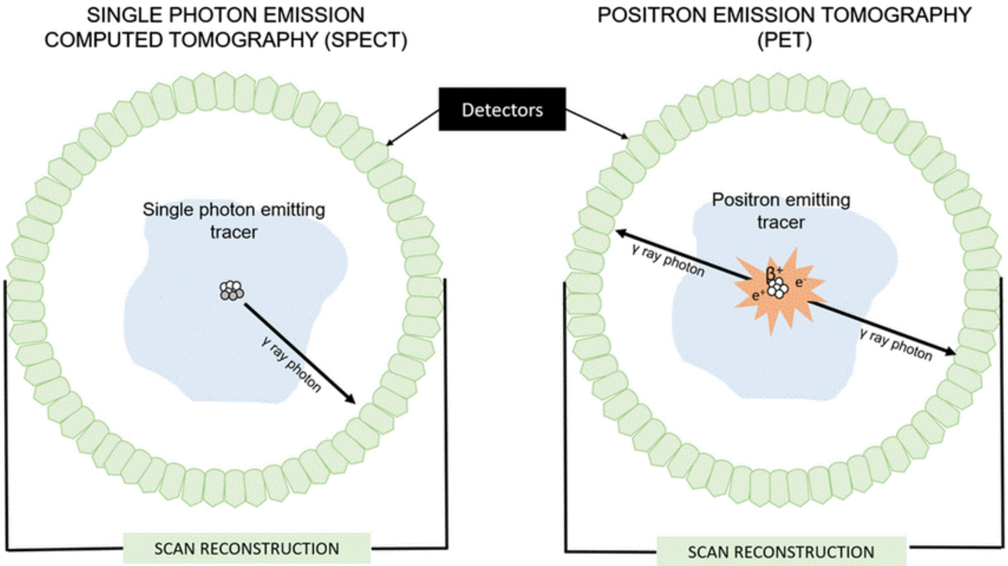

Figure 2. Scan Reconstruction of SPECT(L) and PET(R)

Radiopharmaceuticals & Applications

Feature	^{99m}Tc-SPECT Imaging	^{18}F-PET Imaging
Common tracers	^{99m}Tc-MDP (bone imaging), ^{99m}Tc-sestamibi (cardiac perfusion), ^{99m}Tc-PSMA, ^{99m}Tc-DMSA (renal imaging)	^{18}F-FDG (glucose metabolism), ^{18}F-PSMA, ^{18}F-DOPA, ^{18}F-NaF (bone imaging)
Theranostic applications	Used in SPECT imaging to select candidates for targeted radiotherapy (e.g., ^{99m}Tc-PSMA for prostate cancer leading to ^{177}Lu-PSMA therapy)	Used in PET imaging for staging and guiding targeted radiotherapies (e.g., ^{18}F-FDG for metabolic tumors, ^{18}F-PSMA for prostate cancer)
Organ/system focus	Bone, kidney, heart, tumors	Oncology (most cancers), neurology, cardiology

Table 2. Comparison of Radiopharmaceuticals & Applications Features between Technetium-^{99m}Tc-SPECT and Fluorine 18 ^{18}F-PET

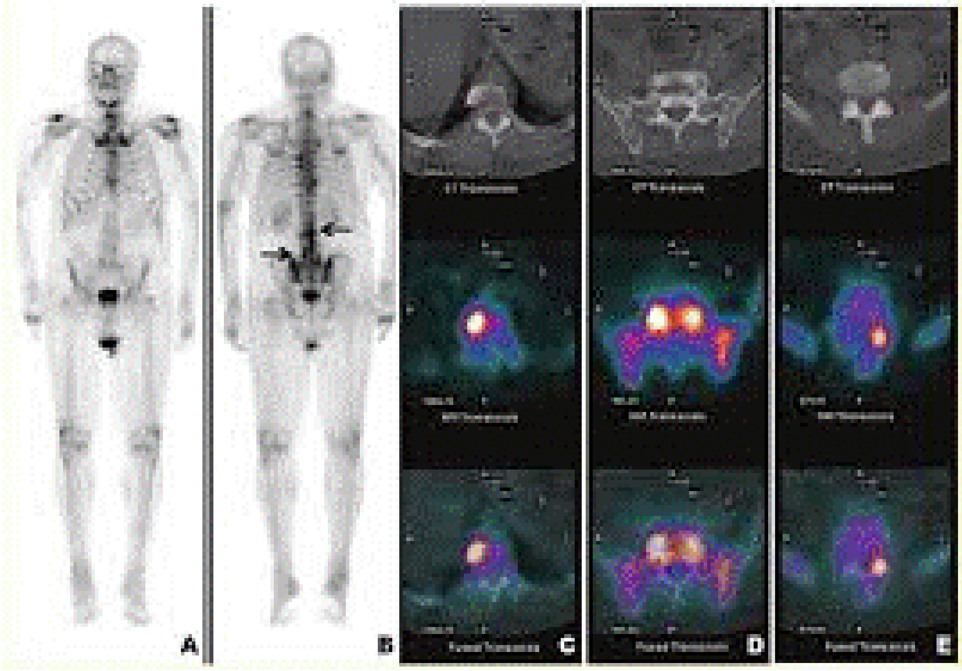

Figure 3. Evaluation of musculoskeletal sarcomas by using ^{99m}Tc-SPECT Imaging and ^{18}F-PET Imaging [1]

Radiation dose & Safety

Feature	^{99m}Tc-SPECT Imaging	^{18}F-PET Imaging
Half-life	6 hours (suitable for transport and use in nuclear medicine)	110 minutes (shorter, requiring on-site or nearby cyclotron)
Radiation dose	Moderate	Slightly higher due to higher energy photons
Patient safety	Safer for frequent scans	Higher radiation exposure but still acceptable for clinical use
Feature	^{99m}Tc-SPECT Imaging	^{18}F-PET Imaging
Half-life	6 hours (suitable for transport and use in nuclear medicine)	110 minutes (shorter, requiring on-site or nearby cyclotron)

Table 3. Comparison of Radiation dose & Safety Features between Technetium-^{99m}Tc-SPECT and Fluorine 18 ^{18}F-PET

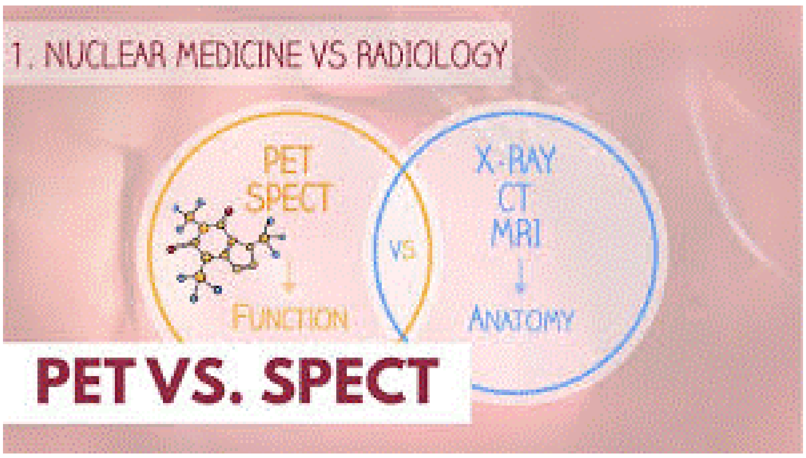

Figure 4. Nuclear medicine VS Radiology

Pros and Cons

Aspect	^{99m}Tc-SPECT	^{18}F-PET
Pros	Widely available, cost-effective, good for bone and organ imaging	Higher resolution, better sensitivity, superior quantification
Cons	Lower sensitivity, longer scan times, limited quantification	Expensive, requires cyclotron, limited availability

Table 4. Pros and Cons between Technetium-^{99m}Tc-SPECT and Fluorine 18 ^{18}F-PET

Conclusion

- ^{99m}Tc-SPECT remains a cost-effective, widely available tool for molecular imaging, particularly in bone scanning and functional imaging.
- ^{18}F-PET provides superior imaging quality, sensitivity, and quantification, making it preferable for oncology, neurology applications.

While SPECT is more accessible, PET is the gold standard for high-resolution, quantitative imaging. The choice between them depends on clinical needs, infrastructure, and cost considerations.

References

1. Garcia, R, Kim EE, Wong FC, and Korkmaz M, et al. “Comparison of fluorine-18-FDG PET and technetium-99m-MIBI SPECT in evaluation of musculoskeletal sarcomas.” J Nucl Med. 37(1996):1476-9.

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