Open Access

Original Article

Improved Myocardial Perfusion Imaging Accuracy: The Benefits of Combined Supine and Prone Acquisition

Saima Seher

Department of Nuclear Cardiology, Armed Forces Institute of Cardiology, Rawalpindi/National Institute of Heart Diseases/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To assess whether prone imaging enhances attenuation correction (AC), thereby improving the specificity and overall diagnostic accuracy of myocardial perfusion imaging (MPI) without compromising sensitivity.
Study Design: Analytical Cross-sectional study.
Place and Duration of Study: Nuclear Department, Army Cardiac Hospital Lahore; from Dec 2023-Jun 2024.
Methodology: One hundred and twenty four patients with fixed or reversible inferior wall perfusion abnormalities and suspected or proven ischemic heart disease were included in the study using non-probability sequential sampling. All patients underwent supine stress/rest SPECT MPI followed by additional stress prone SPECT. Patients with normal MPI and normal perfusion of inferior wall were excluded. Diagnostic accuracy of prone imaging against the coronary artery disease (CAD) was determined based on sensitivity and specificity.
Result: The mean age of the 124 patients who were enrolled was 57.2±11.3 years; 86(69.4%) of them were men. The mean LVEF was 54.4±7.8%, and the mean BMI was 26.6±3.0 kg/m². Among the patients, 69.4% had hypertension and 68.5% had diabetes mellitus. Prone MPI showed an overall accuracy of 78.0%, sensitivity of 64.2%, specificity of 87.7%, positive predictive value of 86.0%, and negative predictive value of 67.6%. Accuracy for supine fixed perfusion abnormalities was 74.0%, but accuracy for reversible defects was 75.0%. Consequently, prone imaging demonstrated a more reliable and balanced diagnostic performance for the detection of CAD.
Conclusion: Combining MPI with prone and supine imaging improved diagnostic accuracy and specificity without compromising sensitivity.

Keywords: Coronary artery disease, Myocardial perfusion imaging, Prone position, sensitivity, specificity, Supine position.

How to Cite This Article: *Seher S. Improved Myocardial Perfusion Imaging Accuracy: The Benefits of Combined Supine and Prone Acquisition. Pak Armed Forces Med J 2026; 76(Suppl-4): S690-S695. DOI: https://doi.org/10.51253/pafmj.v76iSUPPL-4.14174*

INTRODUCTION

Approximately one-third of all deaths in those over 35 are caused by coronary artery disease (CAD), which has a prevalence of 5–8% worldwide.[1] Despite being the most common noninvasive screening method for obstructive CAD, stress single photon emission computed tomography myocardial perfusion imaging (SPECT-MPI) is frequently complicated by artifacts.[2] In SPECT MPI, photon attenuation by soft tissue is a major technical challenge, often producing artifacts that mimic true perfusion defects. Breast and sub diaphragmatic attenuation are the most common causes of false positive interpretations especially in women.[3] Although the combination of modalities was initially experimental, the quick development of hybrid imaging systems using SPECT/CT and photon emission tomography (PET) CT has established both as diagnostic tools in standard clinical practice.4

More than 11 million MPI scans are performed annually in the United States.[5] Patient motion and soft-tissue attenuation are the leading causes of artifacts in MPI. Although advancements in technology have improved attenuation correction (AC), patient-related artifacts still pose challenges for clinicians.[5] The location and severity of attenuation artifacts depend on the position, size, and density of the attenuating tissue relative to the left ventricle. These artifacts may appear as fixed or reversible defects depending on whether the attenuator shifts between stress and rest images.[6] Acquiring additional prone or upright images helps differentiate true perfusion defects from attenuation artifacts, thereby improving the specificity and diagnostic accuracy of MPI.[3]

SPECT/CT systems now offer CT-based attenuation maps thanks to the advancement of hybrid imaging, making it possible to distinguish between actual perfusion problems and attenuation artifacts more precisely. Although the basic physiologic concepts for diagnosing CAD have not changed, the advancement of MPI technology from multitier planar

Correspondence: Dr Saima Seher, Department of Nuclear Cardiology, Armed Forces Institute of Cardiology, Rawalpindi Pakistan

imaging to SPECT, gated SPECT, and more recently hybrid SPECT/CT and PET/CT has improved image quality.[7] With its increased inferior and septal wall counts, less patient motion, and enhanced interpretation accuracy, prone imaging has become a viable attenuation correction technique. It saves more radiation exposure, is less expensive, and takes less time to acquire. However, its usage could be restricted in patients who experience physical pain, especially those who are obese or have large breasts.[8]

MPI is prone to attenuation artifacts that reduce diagnostic accuracy for CAD. Combining supine and prone acquisitions minimizes these artifacts and enhances image interpretation. However, most evidence comes from Western populations with limited applicability to South Asian patients, whose body composition and CAD patterns differ. This study addresses this gap by assessing the diagnostic benefits of combined supine–prone MPI in our local population and helps to give more tailored MPI interpretation in our region.

METHODOLOGY

This was an Analytical Cross-sectional study performed in the Nuclear Cardiology Department of the Army Cardiac Hospital Lahore for a period of 6 months from Dec 2023 to June 2024 after approval from Institutional Ethical Review Board (IERB)(letter# 18/Estb/Acc;Dated: 1st Sep, 2023).Patients were recruited through non-probability consecutive sampling.

The sample size for this study using Sensitivity / Specificity Sample Size Calculator was calculated to estimate the diagnostic performance of SPECT MPI in CAD patients. Based on an expected sensitivity of 89.5%, specificity of 81%, prevalence of CAD 25%,[9] and margin of error 10% at a 95% confidence level, the required sample size was calculated to be 103 patients. To account for an anticipated dropout rate of 20%, the total sample size was increased to 124 patients.

Inclusion Criteria: Patients irrespective of gender with suspected or confirmed ischemic heart disease referred for MPI having fixed and reversible perfusion abnormality in inferior wall were included in the study

Exclusion Criteria: Patients with normal MPI scan and or normal perfusion of inferior wall are excluded.

Data was gathered using a data collection tool after 124 patients who met the inclusion and exclusion criteria were enrolled using non-probability sequential sampling and gave their informed consent. The patient's demographics, comorbid conditions, symptoms, and myocardial perfusion scan results were all included in the data gathering tool.

Each patient completed the 1-day protocol (rest and exercise/pharmacologic stress) for standard electrocardiography-gated 99mTc-sestamibi SPECT MPI. Then, extra prone images were obtained. An intravenous injection (6–10 mCi) of technetium 99m-sestamibi was used for the rest study, and for the stress study, 18-30 mCi was used (according to body weight). Cardiac medications including β-blockers, theophylline derivatives, nitrates, and calcium channel blockers were stopped for 48 hours prior to the study, and patients fasted for 4-6 hours prior to the study.

Rest/stress gated images were obtained using a commercial Siemens Inveto bold dual-head SPECT γ-camera (16 slice CT) with an integrated x-ray transmission system. Parallel-hole low-energy high-resolution collimators were used to acquire emission data when the patient was positioned both supine and prone.With 30 stops and 30 seconds between each stop, the acquisition orbit was the body contour across a 180° arc. A 128 × 128 image capture matrix was used. A 20% symmetric window was used to capture images on the 140-keV photopeak. 45–60 minutes after the radiopharmaceutical was administered, the patient was supine when resting SPECT images were taken. After 30 to 45 minutes of exercise, adenosine stress, and radiopharmaceutical administration, stress SPECT pictures were obtained first in the supine position and subsequently in the prone position. Eight frames per cycle were used to gate the resting and stress SPECT images, with a 20% R–R time acceptance window. The isotope decay factor was applied to all raw datasets, and a revolving cine display was used to check for patient mobility.

Perfusion images were reconstructed using 3-dimensional ordered-subsets expectation maximization and built-in processing that maintained the linearity between photon counts in projection data and pixel values in reconstructed images after the projection data from the electrocardiography-gated SPECT scan was summed. In order to create short-axis images (from apex to base), horizontal long-axis images (from inferior wall to anterior wall), and vertical long-axis images (from septum to lateral wall), Cedars-Sinai Medical Center's cardiac suite SPECT software (quantitative perfusion SPECT and quantitative gated SPECT) reconstructed cross-sectional cardiac images along the short and long axes of the heart.The stress/rest no-AC and stress-prone pictures were analyzed by a nuclear physician in the nuclear cardiology department. These imaging results, the patient's risk level, and other available tests, such as coronary angiography and echocardiography, were used to determine the final diagnosis (i.e., whether the elicited hypoperfusion defect was due to an attenuation artifact or a real defect).

The data was analyzed using the Statistical Package of Social Sciences (SPSS) version 26.0.The Shapiro-Wilk test was used to determine whether the data was normal. It was discovered that every variable had a normal distribution.Continuous variables(age, EF and BMI) were presented as Mean±SD and categorical variables (comorbids andabsence and presence of CAD) were reported as frequencies and percentages. The Chi-square test was used to test the association between the results of the prone scans and the presence of coronary artery disease and odds ratios were calculated with a 95 % confidence interval. A 2 x 2 cross tabulation of prone imaging against the CAD reference standard determined its diagnostic performance of the imaging in terms of sensitivity, specificity, positive and negative predictive values, and the overall accuracy. A p-value ≤0.05 was considered to be statistically significant.

RESULTS

One hundred and twenty-four patients who met the inclusion criteria were enrolled. The mean age was 57.2±11.3 years (range 30–80). The majority of the cohort was males 86(69.4%). The average body-mass index (BMI) was 26.6±3.0 kg/m2 and the average left-ventricular ejection fraction (LVEF) was 54.4±7.8% Table-I.

Prone imaging was found to be effective in differentiating true inferior wall CAD from attenuation artifacts. Among 124 patients, 50(40.3%) had persistent defects on prone imaging, of whom 43(86.0%) had angiographically confirmed CAD, reflecting a high positive predictive value. In contrast, 74 patients (59.7%) demonstrated defect resolution in the prone position, and 50(67.6%) of these patients did not have CAD, indicating that resolved defects reliably represent attenuation artifacts. These results suggest that prone imaging enhances diagnostic specificity by distinguishing true perfusion defects from artifacts without substantially reducing sensitivity Table-II.

Supine myocardial perfusion imaging (MPI) demonstrated high specificity for both fixed (94.6%) and reversible defects (93.0%), indicating that positive findings reliably reflected true defects. Reversible defects, representing stress-induced ischemia that normalized at rest, had slightly higher sensitivity (56.7%) than fixed defects (55.2%), which represent infarcted myocardium. However, a substantial proportion of CAD cases remained undetected in the supine position. Prone MPI improved sensitivity to 64.2% while maintaining relatively high specificity (87.7%), resulting in better overall diagnostic accuracy (78%) as shown in Table-III.

Table-I: Socio-demographic and Clinical Characteristics of Study Participants (n = 124)

Characteristic		Mean±SD
Age (years)		57.2±11.3
Body Mass Index (kg/m²)		26.6±3.0
		Frequency (%)
Gender	Male	86(69.3%)
	Female	38(30.6%)
Comorbids		Frequency (%)
Hypertension		86(69.3%)
Diabetes mellitus		85(68.5%)
Smoking history		65(52.4%)
Family history of CAD		67(54.0%)
Prior myocardial Infarction		33(26.6%)
Asthma		13(10.5%)
		Mean±SD
LVEF (%)		54.4±7.8

CAD=Coronary Artery Disease; LVEF=Left VentricularEjection Fraction

Table-II: Diagnostic Performance of Prone Myocardial Perfusion Imaging (n=124)

Position		CAD		
Prone		Present (n=67)	Absent (n=57)	Total
	Positive	43(64.2%)	7(12.2%)	50
	Negative	24(35.8%)	50(87.8%)	74
Sensitivity	Specificity	PPV	NPV	Accuracy
64.2%	87.7%	86.0%	67.6%	78%

CAD= Coronary Artery disease;PPV=Positive Predictive value;NPV=Negatrive predictive value

DISCUSSION

The current study demonstrates that prone MPI provides improved diagnostic reliability compared to conventional supine imaging in the assessment of CAD. Overall, our findings highlight the benefits of incorporating prone imaging into MPI protocols. Prone acquisition enhances specificity, reduces false-positive results, and improves the identification of true perfusion defects. The combined supine–prone approach offers a practical and time-efficient strategy

Table-III: Diagnostic Performance of Supine Myocardial Perfusion Imaging(n=124)

Supine Position			CAD			
			Present(n=67)	Absent(n=57)	Total	
Fixed		Positive	37(55.3%)	3(5.3%)	40	
		Negative	30(44.7%)	54(94.7%)	84	
Reversible		Positive	38(56.7%)	4(7.01%)	42	
		Negative	29(43.2%)	53(92.9%)	82	
Perfusion defect		Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)	Accuracy (%)
Supine	Fixed	55.2%	94.6%	92.5%	63.9%	74%
	Reversible	56.7%	93.0%	90.5%	64.6%	75%

CAD= Coronary Artery disease;PPV=Positive Predictive value;NPV=Negatrive predictive value

to improve diagnostic accuracy in the evaluation of CAD, supporting its broader clinical adoption, as supported by previous literature.[10,11,12] The enhancement of specificity and overall diagnostic accuracy is also attributable to the ability of true perfusion defect imaging to differentiate from artifacts.[13] This is confirmed in our findings, with prone MPI exhibiting a sensitivity of 64.2% and specificity of 87.7%. This is consistent with prior reports regarding enhanced specificity in the inferior wall with no significant drop in sensitivity.[14]

Attenuation artifacts remain a major limitation in supine MPI, particularly affecting the inferior and anterior walls. The combined supine–prone imaging protocol addresses this limitation by allowing comparison between supine and prone images to distinguish true perfusion defects from artifacts. With just 20%–40% more imaging time needed for prone imaging following supine stress, this method is both feasible and increases diagnostic accuracy.[3] In myocardial perfusion imaging, the prone posture has clear advantages, especially when evaluating the inferior wall since it puts pressure on the belly and makes chest breathing more dominating.[15] As a result, prone imaging is better for showing the inferior wall because it inhibits diaphragmatic mobility. By expanding the breathing region, upright imaging, on the other hand, eliminates the need to push the abdominal organs against gravity. Upright imaging is believed to inhibit diaphragm movement since it is done while the patient is calm. As a result, both imaging techniques allow the inferior wall to be evaluated in terms of breathing-related artifacts.[16]

In our study, reversible perfusion defects were identified in 38 patients with CAD, while 4 defects were seen in patients without CAD, resulted in a diagnostic accuracy of 78.0% for prone MPI while, supine MPI showed a diagnostic accuracy of 75%. These findings indicate that prone imaging enhances the detection of true perfusion defects and stress-induced ischemia by reducing attenuation artifacts, without substantially compromising specificity, thereby complementing supine MPI in the evaluation of CAD. Previous study showed that both CT-based attenuation correction and prone imaging improve diagnostic performance by reducing attenuation artifacts, with CT-based correction showing a slight advantage. Diagnostic accuracy was comparable between the two techniques, though CT attenuation correction demonstrated marginally better performance.[3] Abnormal supine MPI due to diaphragmatic attenuation or motion artifact normalized on prone MPI, reinforcing the role of prone imaging in reducing false-positive findings.[17]

In our study, prone myocardial perfusion imaging (MPI) achieved a diagnostic accuracy of 78.0%, with specificity of 87.7% and sensitivity of 64.2% for detecting CAD. Compared with Costa *et al.*[18], where a combined supine–prone protocol reported higher sensitivity (73.9%) but lower specificity (53.4%), our prone protocol demonstrated superior specificity while maintaining moderate sensitivity. These findings suggest that prone MPI in our cohort effectively reduces false-positive findings and improves overall diagnostic accuracy relative to supine imaging alone, and are largely comparable with previously reported results.[3,11,13] Small discrepancies could be caused by variations in sample size, imaging techniques, or demographic factors.According to a recent meta-analysis, the prone position, which has higher specificity and equivalent sensitivity, can be a suitable substitute for the conventional supine posture in cases of suspected CAD. Additionally, the prone posture proved to be a better standard in the cases of potential problems in the RCA domain.[19]

The study also revealed that men were more likely to have coronary artery disorders, which is consistent with the male preponderance discovered in a prior study published by Sayyed (2022). A study of the literature also showed that the preventive effects of estrogen result in a lower mean value for CAD in young female patients.[20] The decrease of false positive counts when using prone imaging rather than supine imaging alone is consistent with prior studies, where prone imaging enhanced specificity and reduced false positive counts, especially with respect to reversible perfusion defects.[21] The stress supine and prone perfusion images are analyzed using visual and semi quantitative methods in MPI interpretation to discern differences in perfusion. This method is prone to subjectivity and inter-evaluator differences. For a given diagnostic test, inter-evaluator agreement is important because the differences in evaluations from different examiners can lead to large differences in decisions.[19]

The present findings highlight that combining supine and prone acquisitions in MPI can significantly enhance diagnostic accuracy in detecting CAD. The integration of both positions allows for better differentiation between true perfusion defects and attenuation artifacts, particularly in the inferior wall, thereby improving specificity and overall diagnostic reliability. Clinically, this approach minimizes false-positive interpretations and reduces the likelihood of unnecessary invasive investigations such as coronary angiography. Moreover, the combined supine–prone protocol offers a simple, cost-effective, and time-efficient strategy that can be easily implemented in nuclear cardiology departments, even in settings without advanced attenuation correction technology. Hence, adopting this dual-position acquisition protocol may improve patient care by providing more accurate and confident diagnostic assessments of myocardial ischemia.

LIMITATIONS OF STUDY

There are several limitations in our study. The first is that there was no three-month clinical follow-up period, and thus, it is not possible to assess the long-term prognostic accuracy of the combined supine–prone protocol. Additionally, for the combined acquisition approach, the additional camera time may be impractical for centers that have high patient turnover or limited blocked time for imaging. Additionally, study was conducted at a single center, which may restrict the generalizability of the findings to other populations or clinical settings.

CONCLUSION

Prone myocardial perfusion imaging (MPI) improves diagnostic accuracy by decreasing attenuation artifacts and increasing specificity when compared to traditional supine approaches. The combined supine-prone protocol provides an easy and effective way to enhance image interpretation and diagnostic certainty when assessing CAD.

ACKNOWLEDGEMENT

I want to share our gratitude for R&D dept for their support and contribution in completion of the research paper.

Conflict of Interest: None.

Funin Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SS: Data acquisition, data analysis, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Pelletier-Galarneau M, Cabra A, Szabo E, et al. Real-world evidence study on the impact of SPECT MPI, PET MPI, cCTA and stress echocardiography on downstream healthcare utilisation in patients with coronary artery disease in the US. BMC Cardiovasc Disord 2024; 24: 543. https://doi.org/10.1186/s12872-024-04225-y
2. Taasan V, Wokhlu A, Taasan MV, Dusaj RS, Mehta A, Kraft S, et al. Comparative accuracy of supine-only and combined supine-prone myocardial perfusion imaging in men. J Nucl Cardiol 2016; 23(6): 1470-1476. https://doi.org/10.1007/s12350-015-0358-2
3. Tawakol AE, Tantawy HM, Elashmawy RE, Abdelhafez YG, Elsayed YM. Added value of CT attenuation correction and prone positioning in improving breast and subdiaphragmatic attenuation in myocardial perfusion imaging. J Nucl Med Technol 2021; 49(1): 23-29. https://doi.org/10.2967/jnmt.120.255943
4. Alqahtani FF. SPECT/CT and PET/CT, related radiopharmaceuticals, and areas of application and comparison. Saudi Pharm J. 2023; 31(2): 312-328. https://doi.org/10.1016/j.jsps.2022.12.013
5. Johnson SG. Motion Artifacts in SPECT Myocardial Perfusion Imaging. J Nucl Med Technol 2025; 53(2): 138-139. https://doi.org/10.2967/jnmt.125.269853
6. Lee TC, Alessio AM, Miyaoka RM, Kinahan PE. Morphology supporting function: attenuation correction for SPECT/CT, PET/CT, and PET/MR imaging. Q J Nucl Med Mol Imaging. 2015; 60(1): 25.
7. Hatipoğlu F, Çetin N. Clinical utility of CT-based attenuation-correction in myocardial perfusion SPECT imaging. Mol Imaging Radionucl Ther 2023; 32(2): 138. https://doi.org/10.4274/mirt.galenos.2022.68094
8. Abadie B, Liga R, Buechel R, Giannopoulos AA, Pizzi MN, Roque A, et al. Patient centric performance and interpretation of SPECT and SPECT/CT myocardial perfusion imaging: a clinical consensus statement of the European Association of Cardiovascular Imaging of the ESC. Eur Heart J Imaging Methods Pract 2025; 3(1): qyaf043. https://doi.org/10.1093/ehjimp/qyaf043

9. Dilawar H, Habib S, Iqbal J, Hadi I, Abdul Rehman T, Ahmed A,et al. Role of prone SPECT myocardial perfusion imaging in patients with equivocal or abnormal supine myocardial perfusion SPECT. Nucl Med Radiat Ther 2023; 14(1): 525. https://doi.org/10.21203/rs.3.rs-2918437/v1
10. Gheisari F, Kamali M, Liyaghat M, Atefi M, Motamedi A. Optimizing myocardial perfusion scan quality with SPECT: a hybrid systematic narrative review. J Rev Med Sci 2025; 5(1): 1. https://doi.org/10.22034/jrms.2025.498154.1036
11. Ceylan Gunay E, Erdogan A, Yalcin H, Ozcan Kara P. Prone imaging allows efficient radiopharmaceutical usage by obviating the necessity of a rest study in Tc-99m-MIBI myocardial perfusion scintigraphy. Nucl Med Commun 2011; 32(4): 284-288. https://doi.org/10.1097/MNM.0b013e32834462ee
12. Duvall WL, Wijetunga MN, Klein TM, Razzouk L, Godbold J, Croft LB, et al. The prognosis of a normal stress-only Tc-99m myocardial perfusion imaging study. J Nucl Cardiol 2010; 17(3): 370-377. https://doi.org/10.1007/s12350-010-9210-x
13. Arsanjani R, Hayes SW, Fish M, Shalev A, Nakanishi R, Thomson LE, et al. Two-position supine/prone myocardial perfusion SPECT imaging improves visual inter-observer correlation and agreement. J Nucl Cardiol 2014; 21(4): 703-711. https://doi.org/10.1007/s12350-014-9895-3
14. Stathaki M, Koukouraki S, Papadaki E, Tsaroucha A, Karkavitsas N. The benefits of prone SPECT myocardial perfusion imaging in reducing both artifact defects and patient radiation exposure. Arq Bras Cardiol 2015; 105: 345-352. https://doi.org/10.5935/abc.20150122
15. Farrell MB. Combined supine-prone myocardial perfusion imaging: enhancing diagnostic accuracy. J Nucl Med Technol 2024; 52(4): 328-330. https://doi.org/10.2967/jnmt.124.268017
16. Nakaya K, Onoguchi M, Nishimura Y, Kiso K, Otsuka H, Nouno Y, et al. Comparison between prone and upright imaging of the inferior wall using 201TlCl myocardial perfusion SPECT. J Nucl Med Technol 2017; 45(4): 304-308. https://doi.org/10.2967/jnmt.117.197632
17. Kumar A, Singh H, Kaur K, Kumar S, Kaur H, Mittal BR. Comparative analysis of occupational whole-body effective dose and imaging time in myocardial perfusion imaging: dedicated cardiac CZT-SPECT versus conventional SPECT/CT. Clin Transl Imaging 2025; 1–8. https://doi.org/10.1007/s40336-025-00704-0
18. Costa TO, Rocha MD, Camargo RA, Macedo CR. Incremental determinants of the combined supine-prone protocol for myocardial perfusion scintigraphy. Arq Bras Cardiol Imagem Cardiovasc 2023; 36(3). https://doi.org/10.36660/abcimg.20230060i
19. Mirshahvalad SA, Chavoshi M, Hekmat S. Diagnostic performance of prone-only myocardial perfusion imaging versus coronary angiography in detecting coronary artery disease: a systematic review and meta-analysis. J Nucl Cardiol 2022; 29(3): 1339-1351. https://doi.org/10.1007/s12350-020-02376-x
20. Sayed AI. Gender differences in coronary artery disease, clinical characteristics, and angiographic features in the Jazan Region, Saudi Arabia. Cureu 2022; 14(10): e30239. https://doi.org/10.7759/cureus.30239
21. Gutstein A, Solodky A, Mats I, et al. Feasibility of myocardial perfusion SPECT with prone and half-time imaging. Nucl Med Commun 2011; 32: 386-391. https://doi.org/10.1097/MNM.0b013e328343d68e

....