

The Appropriate Acquisition Time Interval Following Injection of ^{99m}Tc -Sestamibi with Water Protocol in Single Photon Emission Computed Tomography Myocardial Perfusion Imaging: First Experience in Indonesia

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Abstract

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Introduction: According to EANM/ESC guideline, image acquisitions in stress test should be begun at 30-60 minutes after tracer administration. Our center is a referral hospital for nuclear medicine imaging with many patients but limited number of gamma camera. The shorter time between injection of radiopharmaceutical and imaging acquisition will add to the number of examinations that can be performed. The aim of this study was to evaluate the appropriate acquisition time interval with water protocol in ^{99m}Tc -Sestamibi SPECT myocardial perfusion imaging.

Methods: Patients who were referred to undergo stress MPI between October 2020 to December 2020 were included in this study. Cardiac stress procedure was performed using treadmill with modified Bruce Protocol. Subjects drank a total of 330 mL water following ^{99m}Tc -Sestamibi injection. Image acquisitions were performed 10 and 30 minutes afterwards. Quantitative assessment was done by calculating target background ratio (TBR). Statistical analysis was performed using student t-test with Microsoft Excel version 2019. P -value < 0.05 was considered to be statistically significant.

Result: Thirty out of 35 subjects were included in this study. Sixteen of them are male and 14 are female with a mean age of 48.7 years old (28 — 80). Mean target background uptake ratio (TBR) in 10- and 30-minutes images were 0.67 (0.44 – 1.11) and 0.76 (0.43 — 1.18) respectively (p -value = 0.15).

Conclusion: There was no significant difference of target to background ratio between 10- and 30-minutes acquisition time interval following injection of ^{99m}Tc -Sestamibi with water protocol in myocardial perfusion imaging.

Introduction

Coronary artery disease (CAD) remains the world's leading cause of death.¹ Single Photon Emission Computed Tomography (SPECT) Myocardial Perfusion

Imaging (MPI) using ^{99m}Tc -Sestamibi can be used to diagnose and evaluate the prognosis of CAD. According to European Association of Nuclear Medicine/European Society of Cardiology (EANM/ESC) guideline, image acquisitions should be

begun at 30-60 minutes after tracer administration in stress test.²

In our center, patients should drink milk at time between injection and imaging to increase clearance of tracer from the liver and gallbladder as a standard protocol. However, some patients are lactose intolerant, and this may cause diarrhea and abdominal discomfort after consume milk and sometimes disturb/prolong the MPI procedure.

Our center is a referral center hospital for nuclear medicine imaging with many patients but a limited number of gamma camera and we often find patients with history of lactose intolerance. The aim of this study was to evaluate the appropriate acquisition time interval between injection of radiopharmaceutical and image acquisition using water protocol in SPECT myocardial perfusion imaging.

Material And Methods

Thirty-five patients who were referred to Department of Nuclear Medicine and Molecular Imaging Dr. Hasan Sadikin General Hospital for MPI procedure between October 2020 to December 2020 were included in this study. The exclusion criteria were as follow: patient with no history of essential fluid restriction, currently taking anti-motility or pro-motility drug, not pregnant or lactating at the time of MPI procedure, and had contraindications to perform exercise stress test using treadmill. Patients also should not consume caffeine containing products for at least 12 hours prior to MPI procedure, stop β -blocker treatment for 24 hours, and stop phosphodiesterase inhibitor for 24-48 hour before MPI procedure. All subjects were asked to fast for at least 4 hours prior to MPI procedure. Informed consent was obtained from all subjects.

Stress procedure was performed using treadmill with modified Bruce Protocol. ^{99m}Tc -Sestamibi was use as radiopharmaceutical. Subjects who reached

minimal 85% of maximal heart rate were asked to drink a total of 330 mL water after radiopharmaceutical injection. Image acquisitions were performed at 10 and 30 minutes after radiopharmaceutical injection.

Region of interest (ROI) were drawn on heart and liver on 10- and 30-minutes images and then the target background ratio (TBR) was calculated, as shown in Figure 1. Statistical analysis was performed using student t-test with Microsoft Excel version 2019 to evaluate the quantitative assessment of heart to liver background ratio. P -value < 0.05 was considered as statistically significant.

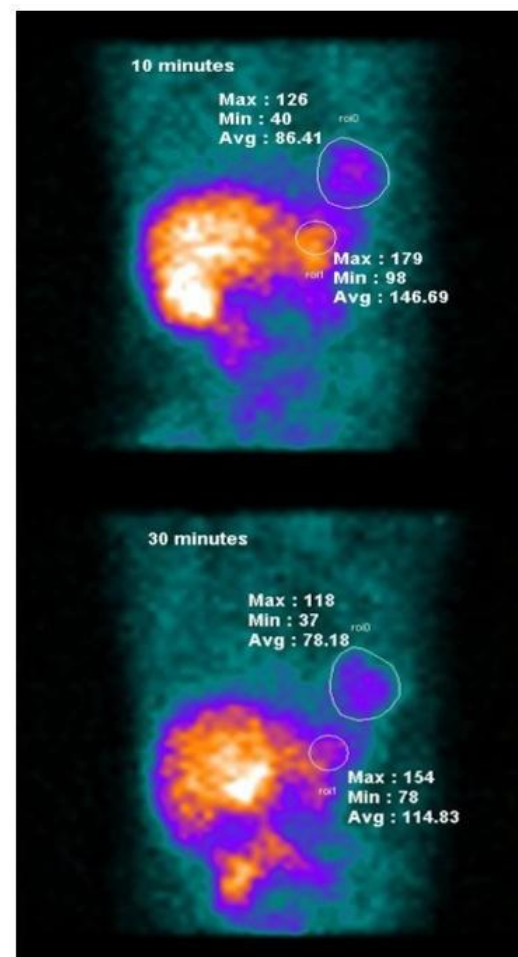


Figure 1. Comparison of ^{99m}Tc -MIBI uptake in the target (heart) and the background (liver) on 58 years old male with atypical chest pain

Result

A total of 30 out of 35 subjects (86%) were included in this study. Five of 35 subjects were excluded due to essential fluid restriction, had contraindications to perform exercise stress test using treadmill, and didn't reach optimal target maximal heart rate. Subjects consist of 16 males (53%) and 14 females (47%) with mean age of 48.7 (28 — 80 years-old). Mean target background ratio (TBR) in 10- and 30- minutes acquisition time interval following injection of radiopharmaceutical were 0.67 (0.44—1.11) and 0.76 (0.43—1.18) respectively (p -value = 0.15), as shown on Figure 2.

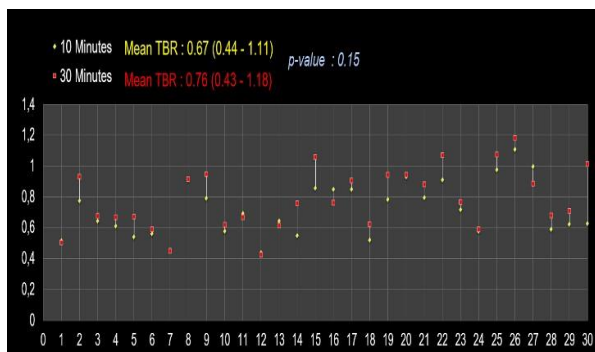


Figure 2. Mean target to background uptake ratio in 10- and 30-minutes post injection of radiopharmaceutical

Discussion

Coronary artery disease (CAD) remains the world's leading cause of death with 16% of the world's total death. According to World Health Organization, there were 2 to 8.9 million deaths in 2019.¹ Prevention and early non-invasive diagnosis or early detection with high sensitivity and high specificity must be the priority to slow down the increasing death caused by CAD. SPECT-MPI using radiopharmaceutical ^{99m}Tc-Sestamibi can be used to diagnose and evaluate the prognosis of CAD. It was found to be more cost effective than any other diagnostic modality, and more

sensitive than exercise Electrocardiogram (ECG) in detecting myocardial ischemia. It has 85-95% sensitivity, and 75% specificity. The specificity can be increased up to 94% if combined with ECG gated data.³⁻⁵ Stress images may help determine the degree of inducible ischemia or viable myocardium that are amenable to revascularization, evaluate myocardial viability before revascularization and following-up after revascularization such as coronary artery bypass graft or angioplasty.³⁻⁶

Physiological radioactivity uptake in the liver, bowel or stomach could interfere the interpretation of MPI. This phenomenon can be reduced by using iterative reconstruction and attenuation correction but a high tracer activity around the heart will still influence the evaluation of the myocardium.^{7,8} Several methods to reduce the digestive activity have been described, such as filling the stomach with either solids or fluids⁹⁻¹¹, increasing the gastrointestinal activity by using metoclopramide drug¹², keeping the patient standing for several minutes after tracer injection¹³, or even ingesting iodinated contrast medium to absorb the emitted gamma-rays¹⁴. Prolonging the delay imaging between injection and image acquisition can lead to a significant decrease in the hepatic activity but also by increasing the activity in the bowel loops adjacent to the inferior wall of the heart.^{11,12,14}

Patients should take fatty meal at time between injection and imaging to increase clearance of tracer from the liver and gallbladder as a standard protocol of MPI in some centers.² Our department usually ask patients to drink milk to reduce physiological infra-cardiac organs uptake. However, some patients are lactose intolerant, and this may cause diarrhea and abdominal discomfort. Data on Indonesian population showed that the prevalence of lactose malabsorption and intolerance are quite high, between 21% to 73%.¹⁵⁻¹⁷ Those patients will feel abdominal discomfort as well as diarrhea after MPI procedure, and sometimes disturb the MPI

procedure.¹³ In this study we use water instead of milk, to minimize the infra-cardiac uptake that can interfere with the interpretation of SPECT MPI. Our previous study compared subjects in first group (drank 500 mL of milk) and second group (drank 330 mL of water) after doing physical stress MPI procedure with acquisition time 30 minutes after ^{99m}Tc-Sestamibi injection, and we found that water was as good as milk in reducing the infra-cardiac tissue tracer uptake. In this study, ^{99m}Tc-Sestamibi was used as radiopharmaceutical for MPI. Since this radiopharmaceutical is a lipophilic agent, patients were advice to take solid fatty meal for breakfast on the day of MPI procedure.^{7,8}

Preparation before MPI procedure is important to get a good quality of images. Subjects should not take any food for at least 4 hours to prevent stress-induced gastric distress and minimize splanchnic blood distribution.¹⁸ Subjects must have no contraindications to perform exercise stress test using treadmill. Caffeine containing products must not be consumed for at least 12 hours prior MPI procedure, to avoid decreased vasodilatation respond from vasodilator stress agents, which will lead to reduced sensitivity in detecting myocardial ischemia. Subjects were also suggested to stop β -blocker treatment for 24 hour and phosphodiesterase inhibitor for 24-48 hour before MPI procedure.¹⁹

Out of 35 subjects, 5 subjects were excluded because they didn't reach minimal target heart rate (85% maximal heart rate) and had contraindications to undergo the exercise test. Based on EANM/ESC guideline, patients are said to achieve maximum exercise stress test when they are able to reach $\geq 85\%$ of their age-predicted maximum heart rate (maximal age-predicted heart rate = $220 - \text{age}$).²

In accordance to conventional guideline, image acquisitions should be performed 15 — 60 minutes after tracer administration.¹⁹ Strauss, et al. said that image acquisitions with ^{99m}Tc based tracer

should be performed after liver radioactivity has sufficiently cleared, this was usually between 15-30 minutes after tracer administration.²⁰ While according to EANM/ESC guideline, image acquisitions should be begun at 30-60 minutes after tracer administration.² In this study, MPI was done on 10 and 30 minutes following ^{99m}Tc-Sestamibi injection intravenously. Ten minutes acquisition time following injection of radiopharmaceutical based on the consideration that the time taken by patients between physical stress MPI, and imaging procedure was about 10 minutes. The 10 minutes image after radiopharmaceutical injection was considered as direct imaging, and 30 minutes image as control, based on EANM/ESC guideline, as an appropriate time for image acquisitions.²

All subjects were scanned in supine position with arms raised above the head and the knees supported with pillow under it. Shoulders and arms were comfortably positioned in order to reduce movement and pain, particularly in older subjects, to make them feel as comfortable as possible to minimize body motion as suggested by Dorbala, et al..¹⁹ Female subjects were imaged without brassiere, and chest band was used to minimize breast attenuation and minimize motion. Chest band could also be used in male subjects to minimize body motion as suggested by Hesse B. et al.² From the quantitative assessment results, we found that there was no significant difference in TBR of heart to liver ratio between 10- and 30-minutes acquisition time interval after radiopharmaceutical injection as seen in Figure 2, with p-value = 0.15 ($p > 0.05$).

Conclusion

Our quantitative study showed that there was no significant difference in target to background ratio between 10- and 30-minutes acquisition time interval following injection of ^{99m}Tc-Sestamibi in water

protocol SPECT myocardial perfusion imaging procedure. The shorter acquisition time interval in stress exercise test using water protocol SPECT myocardial perfusion imaging (10-minutes following injection of ^{99m}Tc -Sestamibi) can be used in daily practice to increase the number of

examinations that can be performed without reduce the image quality of MPI results.

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Not applicable.

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