An Assessment of Myocardial Perfusion Count Distribution Differences among Various Image Reconstruction Methods in Myocardial Perfusion Scans Using Three Head Gamma Camera

Jumpei Suyama, MD, PhD, Yoichi Katayama, MD, PhD, Kumi Hatano, MD, Keita Yamana, MD, Akira Shinozuka, MD, PhD, Takehiko Gokan, MD, PhD, Yasushi Akutsu, MD, PhD, Yusuke Kodama, MD, PhD, Kyoichi Kaneko, MD, PhD and Tadashi Takase

Received: May 2, 2017/Revised manuscript received: August 2, 2017/Accepted: August 2, 2017
J-STAGE Advance published: August 23, 2017
© The Japanese Society of Nuclear Cardiology 2017

Abstract

Purpose: The novel 3 Detector SPECT ‘GCA-9300R’ is equipped with attenuation correction algorithm of 3D-OSEM and SSPAC. The combination of this highly sensitive gamma camera with high quality techniques seems very promising concerning diagnostic value. The aim of this study is to comprehend the difference of tracer uptake in MPS under the usage of 3D-OSEM, SSPAC method compared with FBP using triple head gamma camera.

Methods: We examined a total of 40 consecutive cases (20 cases for both male and females), in which conducted myocardial perfusion scans and diagnosed as no heart ischemic state. The examination was conducted under rest first 1-day protocol. Comparative analysis was conducted between FBP and 3D-OSEM (rest and stress), FBP and SSPAC (rest and stress), and FBP and prone images (stress) as well as 3D-OSEM and prone images (stress).

Results: In FBP, we observed a lower count distribution in septal region, higher count distribution in apical region and apical side of the lateral region. 3D-OSEM showed slightly lower count distribution compared with FBP in the septal, lateral and apical region. The reduction was more prominent with the males. Regarding SSPAC, in comparison with FBP, count elevations were observed in the inferior and septal regions while in the lateral and apical region the count was reduced. There was no statistically significant count difference between SSPAC and prone image in the inferior regions.

Conclusion: With GCA-9300R, 3D-OSEM has the tendency toward count reduction in the septal, lateral and apical regions. On the other hand, SSPAC could reduce the count reduction in sepal and inferior regions toward FBP, and could prove to be a very helpful tool in the diagnosis of ischemia.

Keywords: 3D-OSEM, CT-AC, Prone, SSPAC, Three head detector

Ann Nucl Cardiol 2017; 3 (1): 34-41

The Toshiba 3 Detector SPECT ‘GCA-9300R’ was released in 2014, and it was expected to make diagnostic performance superior, specializing in the head and heart regions. This novel triple head gamma camera has the structural benefit and advantage of being highly sensitive. In recent years, Japan has seen an increase in the rate of brain and myocardial region examination utilizing nuclear medicine. This new equipment will be able to meet the demand of Japanese clinicians.

Regarding the evaluation of myocardial perfusion, with...
Differences among Various Reconstruction Methods in MPS

Ann Nucl Cardiol 2017: 3 (1): 34-41

Suyama et al. — 35 —

We examined a total of 40 consecutive cases (20 cases for both male and females), conducted using MPS at Showa University Hospital and diagnosed as no heart ischemic state clinically between August 2014 and August 2017. Based on diagnostic images including MPS and clinical data, the clinical diagnosis was defined by cardiovascular internal medicine physicians. The subjects underwent exercise (total n=13; m7, f6) or pharmacological (total n=27; m13, f14) stress and rest tests. In 10 of the male cases and 14 of the female cases who were conducted the MPS in the latter stage of this study, the prone images were added because they are preferable as control subjects to be compared with SSPAC.

The examination was conducted under rest first 1-day protocol. For the rest test a dose of 185 MBq of $^{99m}$Tc tetrofosmin (Nihon MediPhysics, Tokyo, JP) was injected intravenously, and for the stress test a dose of 555 MBq was used. In pharmacological stress, Adenosine (Daichi Sankyo Pure Chemicals, Tokyo, JP) was infused for 6 minutes at a rate of 140 μg · kg-1 · minutes-1. A triple-detector SPECT system (GCA-9300R; Toshiba Medical Systems, Tochigi, JP) equipped with a low energy high-resolution collimator was also used. The gated SPECT data was acquired under the following parameters; 360° step-and shoot rotation; 64 × 64 matrix; 30 seconds per step; 16 frames of cardiac cycle. The cut-off frequency of the Butterworth filter was 0.25 cycle/cm.

The data was reconstructed with FBP, 3D-OSEM, SSPAC, and databases of these three sets of data as well as prone position data were created for each gender respectively. 3D-OSEM was set in 3 iterations and 10 subsets. The database was made up using 17-segment model (Fig. 1) with the software ‘Heart function View’ (Nihon MediPhysics, Tokyo, JP) and distribution differences of the segmental % uptake value were compared statistically. The polar map data of every patient was compiled by the software automatically, and when the included ranges seemed to be inadequate, the ranges were corrected by well-experienced radiologists. Comparative analysis was conducted between FBP and 3D-OSEM (rest and stress), FBP and SSPAC (rest and stress), and FBP and prone images (stress) as well as 3D-OSEM and prone images (stress). The differences in segmental values were originally calculated on the basis of t test. In the segments where the data did not show normal statistical distribution, the Mann-Whitney U test was used. The non-parametric multivariate analysis with Steel-Dwass procedure was also conducted. And a P value of less than 0.05 was considered statistically significant. In this study, the regions of p<0.05 and p<0.01 were considered as mild and severe low count areas respectively. The Ethics Committee of the Showa University approved the study.

Materials and methods

We examined a total of 40 consecutive cases (20 cases for both male and females), conducted using MPS at Showa University Hospital and diagnosed as no heart ischemic state clinically between August 2014 and August 2017. Based on diagnostic images including MPS and clinical data, the clinical diagnosis was defined by cardiovascular internal medicine physicians. The subjects underwent exercise (total n=13; m7, f6) or pharmacological (total n=27; m13, f14) stress and rest tests. In 10 of the male cases and 14 of the female cases who were conducted the MPS in the latter stage of this study, the prone images were added because they are preferable as control subjects to be compared with SSPAC.

The examination was conducted under rest first 1-day protocol. For the rest test a dose of 185 MBq of $^{99m}$Tc tetrofosmin (Nihon MediPhysics, Tokyo, JP) was injected intravenously, and for the stress test a dose of 555 MBq was used. In pharmacological stress, Adenosine (Daichi Sankyo Pure Chemicals, Tokyo, JP) was infused for 6 minutes at a rate of 140 μg · kg-1 · minutes-1. A triple-detector SPECT system (GCA-9300R; Toshiba Medical Systems, Tochigi, JP) equipped with a low energy high-resolution collimator was also used. The gated SPECT data was acquired under the following parameters; 360° step-and shoot rotation; 64 × 64 matrix; 30 seconds per step; 16 frames of cardiac cycle. The cut-off frequency of the Butterworth filter was 0.25 cycle/cm.

The data was reconstructed with FBP, 3D-OSEM, SSPAC, and databases of these three sets of data as well as prone position data were created for each gender respectively. 3D-OSEM was set in 3 iterations and 10 subsets. The database was made up using 17-segment model (Fig. 1) with the software ‘Heart function View’ (Nihon MediPhysics, Tokyo, JP) and distribution differences of the segmental % uptake value were compared statistically. The polar map data of every patient was compiled by the software automatically, and when the included ranges seemed to be inadequate, the ranges were corrected by well-experienced radiologists. Comparative analysis was conducted between FBP and 3D-OSEM (rest and stress), FBP and SSPAC (rest and stress), and FBP and prone images (stress) as well as 3D-OSEM and prone images (stress). The differences in segmental values were originally calculated on the basis of t test. In the segments where the data did not show normal statistical distribution, the Mann-Whitney U test was used. The non-parametric multivariate analysis with Steel-Dwass procedure was also conducted. And a P value of less than 0.05 was considered statistically significant. In this study, the regions of p<0.05 and p<0.01 were considered as mild and severe low count areas respectively. The Ethics Committee of the Showa University approved the study.

Materials and methods

We examined a total of 40 consecutive cases (20 cases for both male and females), conducted using MPS at Showa University Hospital and diagnosed as no heart ischemic state clinically between August 2014 and August 2017. Based on diagnostic images including MPS and clinical data, the clinical diagnosis was defined by cardiovascular internal medicine physicians. The subjects underwent exercise (total n=13; m7, f6) or pharmacological (total n=27; m13, f14) stress and rest tests. In 10 of the male cases and 14 of the female cases who were conducted the MPS in the latter stage of this study, the prone images were added because they are preferable as control subjects to be compared with SSPAC.

The examination was conducted under rest first 1-day protocol. For the rest test a dose of 185 MBq of $^{99m}$Tc tetrofosmin (Nihon MediPhysics, Tokyo, JP) was injected intravenously, and for the stress test a dose of 555 MBq was used. In pharmacological stress, Adenosine (Daichi Sankyo Pure Chemicals, Tokyo, JP) was infused for 6 minutes at a rate of 140 μg · kg-1 · minutes-1. A triple-detector SPECT system (GCA-9300R; Toshiba Medical Systems, Tochigi, JP) equipped with a low energy high-resolution collimator was also used. The gated SPECT data was acquired under the following parameters; 360° step-and shoot rotation; 64 × 64 matrix; 30 seconds per step; 16 frames of cardiac cycle. The cut-off frequency of the Butterworth filter was 0.25 cycle/cm.

The data was reconstructed with FBP, 3D-OSEM, SSPAC, and databases of these three sets of data as well as prone position data were created for each gender respectively. 3D-OSEM was set in 3 iterations and 10 subsets. The database was made up using 17-segment model (Fig. 1) with the software ‘Heart function View’ (Nihon MediPhysics, Tokyo, JP) and distribution differences of the segmental % uptake value were compared statistically. The polar map data of every patient was compiled by the software automatically, and when the included ranges seemed to be inadequate, the ranges were corrected by well-experienced radiologists. Comparative analysis was conducted between FBP and 3D-OSEM (rest and stress), FBP and SSPAC (rest and stress), and FBP and prone images (stress) as well as 3D-OSEM and prone images (stress). The differences in segmental values were originally calculated on the basis of t test. In the segments where the data did not show normal statistical distribution, the Mann-Whitney U test was used. The non-parametric multivariate analysis with Steel-Dwass procedure was also conducted. And a P value of less than 0.05 was considered statistically significant. In this study, the regions of p<0.05 and p<0.01 were considered as mild and severe low count areas respectively. The Ethics Committee of the Showa University approved the study.

Results

The basic patients’ data is shown in Table 1. Naturally the height and body weight of the males was higher than that of
the females’, whereas the BMI was not so different. EF also showed no significant difference between the genders, although the results for the females were slightly higher than those for the males. EDV and ESV were higher in males with statistical significance. These differences can be considered within the general gender difference of the left ventricular cavity size. The average for SSS was 1.24 ± 1.31 (range 0-4).

The data was not normally distributed in following segments; seg.4 prone in female, seg.5 SSPAC at rest in male, seg.8 3D-OSEM at stress in male and SSPAC at stress in male, seg.10 FBP at rest in female and 3D-OSEM at stress in male, seg.12 FBP at rest in female and SSPAC at stress in female, seg.13 SSPAC at stress in female, seg.14 SSPAC at stress in female and SSPAC at stress in male, seg.16 FBP at rest in both genders.

The polar map data reconstructed in FBP at stress test is shown in Fig. 2. In FBP lower count distributions in the septal region, whereas they are high in the apical region. Males showed lower value in the septal and inferior regions. In middle portion of the septal to inferior region (Seg.9, 10) The' counts was lower for males than for females with statistically significance.

The acquired databases concerning mean blood supply and standard division are shown in Fig. 3. The statistical results between 2 objects among every image are shown in Fig. 4-6. 3D-OSEM showed mild lower count distribution against FBP in the lateral, septal and apical region for the males. The slight reduction in the lateral regions was observed for the females. One segment of septal region (rest) and inferior region (stress) were also observed. Totally, the lower count regions were higher for the males.

In SSPAC, severely elevated count areas were observed in septal regions and this tendency was stronger in female subjects. In the inferior region the count elevation effect was confirmed in seg.4, 10 for the females and seg.4 for the males, and among them severe count elevation was only observed in seg.10 for the females. On the other hand, in the lateral and apical region the SSPAC count was lower than FBP, and these regions area mostly matched with the original higher count distribution by FBP. These count changes were more predominant in the stress test than the rest test.

Regarding the inferior wall, there were no significant difference between SSPAC and Prone image. Prone image showed a dramatically higher count distribution in the inferior and lateral regions than FBP. Compared with prone image SSPAC, prone image showed an obviously lower count in the lateral and septal regions and higher count in septal regions.

The result of non-parametric multivariate analysis are shown in Table 2. Although the number of segment with significant difference was less than 2 comparative test, fundamental tendency was similar. The segment showing significant difference only in the analysis was not confirmed.

### Table 1 Patients’ general data

|         | Age (yr) | Height (cm) | Weight (kg) | BMI (kg/m²) | EF (%) | EDV (ml) | ESV (ml) |
|---------|----------|-------------|-------------|-------------|--------|----------|----------|
| male    | 70.0 ± 10.7 | 165.8 ± 7.63 | 67.0 ± 10.2 | 24.1 ± 2.41 | 63.8 ± 11 | 63.2 ± 14.2 | 25.1 ± 7.64 |
| female  | 68.6 ± 16.0 | 153.6 ± 7.86 | 54.5 ± 10.3 | 23.2 ±4.23  | 69.5 ±10.3 | 49.5 ±10.4 | 16.4 ±7.20  |

BMI=body mass index
EF=ejection fraction

### Discussion

In MPS, the inhomogeneous count reduction of the RI tracer is inescapable because there is the attenuation reduction, and the heart has some surrounding organs such as the lungs, diaphragm, liver, stomach and spine. The artifact commonly
Fig. 3  Each database showing (a) male in rest test (b) male in stress test (c) female in rest test (d) female in stress test
Fig. 4  Comparison between 3D-OSEM with FBP. a: Male rest, b: Male stress, c: Female rest, d: Female stress.
Count reductions were observed in the septal, lateral and apical regions. The reduction was more prominent with the males. Small arrow represents mild difference and large arrow represents severe difference respectively.

Fig. 5  Comparison between SSPAC with FBP. a: Male rest, b: Male stress, c: Female rest, d: Female stress.
Counts reductions were observed in the lateral and apical regions. The count elevations were observed in the septal and inferior regions. These tendencies were most prominent in the stress test.
Small arrow represents a mild difference and large arrow represents severe difference of SSPAC in contrast with the FBP value respectively.

Fig. 6  Relationship with prone image in stress test. a: Male FBP vs Prone, b: Male SSPAC vs Prone, c: Female FBP vs Prone, d: Female SSPAC vs Prone.
The obvious effect of prone image elevating the counts in the inferior and lateral regions was observed. Regarding inferior regions, there were no statistically significant differences between SSPAC and prone image.
Small arrow represents a mild difference and large arrow represents severe difference of prone image in contrast with the FBP or SSPAC value respectively.
impedes our assessment especially in the inferior region. It was reported that in healthy subjects the accumulation reduction occurred in the inferior and septal wall with a statistically significant difference (4). The generation of an attenuation coefficient map to attenuation correction was recommended as one of the various reporting methods. Today, this technique has been mainly adapted to CT-AC (1), whereas in the past methods using an external source were attempted. Although the additional data acquisition is needed, the prone image has also been used as a preferable tool ever since the initial stage of MPS (2, 3).

The triple head gamma camera has the structural benefit and advantage of being highly sensitive. For the detector, a smaller than usual, 2-inch photomultiplier tube which is smaller than

### Table 2a

| Seg. | FBP vs 3D-OSEM rest | FBP vs 3D-OSEM stress | FBP vs SSPAC rest | FBP vs SSPAC stress |
|------|---------------------|-----------------------|-------------------|---------------------|
| 1    |                     |                       |                   |                     |
| 2    |                     |                       |                   |                     |
| 3    |                     |                       |                   |                     |
| 4    |                     |                       |                   |                     |
| 5    | ○ FBP>OSEM         |                       |                   | ◊ FBP<SSPAC         |
| 6    |                     |                       |                   | ◊ FBP<SSPAC         |
| 7    |                     |                       |                   |                     |
| 8    | ○ FBP>OSEM         | ○ FBP>OSEM            | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 9    | ○ FBP>OSEM         | ○ FBP>OSEM            | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 10   |                     |                       |                   |                     |
| 11   |                     |                       |                   |                     |
| 12   |                     |                       |                   |                     |
| 13   | ○ FBP>OSEM         |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 14   | ○ FBP>OSEM         | ○ FBP>OSEM            | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 15   | ○ FBP>OSEM         |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 16   | ○ FBP>OSEM         |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 17   |                     |                       |                   | ◊ FBP<SSPAC         |

○ → P<0.05
◊ → P<0.01

### Table 2b

| Seg. | FBP vs 3D-OSEM rest | FBP vs 3D-OSEM stress | FBP vs SSPAC rest | FBP vs SSPAC stress |
|------|---------------------|-----------------------|-------------------|---------------------|
| 1    |                     |                       |                   |                     |
| 2    |                     |                       |                   |                     |
| 3    |                     |                       |                   |                     |
| 4    |                     |                       |                   |                     |
| 5    |                     |                       |                   |                     |
| 6    |                     |                       |                   |                     |
| 7    |                     |                       |                   |                     |
| 8    |                     |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 9    |                     |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 10   |                     |                       |                   |                     |
| 11   |                     |                       |                   |                     |
| 12   |                     |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 13   | ○ FBP>OSEM         |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 14   | ○ FBP>OSEM         |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 15   | ○ FBP>OSEM         |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 16   | ○ FBP>OSEM         |                       | ◊ FBP<SSPAC       | ◊ FBP<SSPAC         |
| 17   |                     |                       |                   | ◊ FBP<SSPAC         |

○ → P<0.05
◊ → P<0.01
Differences among Various Reconstruction Methods in MPS

Suyama et al.

Ann Nucl Cardiol 2017; 3 (1) : 34-41

The major limitation of this study was the small number of patients. In addition, the results may be biased because the study was conducted in a single institution. The comparative analysis between SSPAC and prone image in larger studies would emphasize the accumulation difference more, and low perfusion count regions in FBP would be expressed as lower perfusion. Furthermore, in 3D-OSEM the lateral wall was assessed lower than in FBP, and we don’t have a clear explaining for this result yet. However it has been reported that the high spatial resolution application may have the ability to separate inferior wall from adjust bowel uptake (6). Therefore other studies will be needed to assess the diagnostic value of 3D-OSEM in MPS.

The SSPAC is a method used to create an attenuation coefficient map using the sub-window set on the lower energy side than photopake of projection data. Because the attenuation coefficient map is made by the SPECT data itself, the advantage of this method is a lack of location misregistration on the attenuation coefficient map without the need to add the radiation exposure. There are some reports that have commented on the benefits in the assessment of RCA regions using SSPAC in MPS (11, 12). Yamanouchi et al (11). reported the SSPAC’s utility for 150 patients on whom MPS was conducted for the purpose of cardiac disease diagnosis, and concluded that the diagnostic value including sensitivity, specificity, accuracy, positive predictive value as well as negative predictive value had significantly improved compared with non-corrected images. Regarding SSPAC, the count elevation effect in the inferior region has already been confirmed. In our study, the effect was shown in both genders with statistical significance, however the effect was lesser than compared with FBP. Conversely, from this result it could be speculated that the risk of over-correction which we faced in the inferior wall by CT-AC could be avoided. In this study, the highest count elevation was observed in the septal region. And the accumulation value tends to become low in clinical cases. It may be due to attenuation reduction caused deep inside of the body, and the low count of this region is a common feature when compared to the 360° rotation acquisition. Regarding lateral wall especially in anterior side, although the higher counts were observed especially in FBP, it was dissolved in SSPAC and the effect also shows a significant difference statistically. As a result, SSPAC can be considered to have the benefit of reducing the proper accumulation unbalance of septal, inferior and lateral wall in FBP which sometimes misleads us into misdiagnosis. However, we should always carefully monitor septal count reduction in the apical region.

OSEM has been widely used in the SPECT, because it allows for improved signal to noise ratio in the low count region and avoids streak artifact in the high count region. In clinical application, it helps us to detect the ischemia in the inferior wall in MPS, however it was also reported that it didn’t contribute to an improved depiction of the inferior wall compared with FBP (6). Recently three-dimensional methods based on conventional 2D-OSEM with added collimator opening revise were introduced and from this application we can get even more improved images. The utility of 3D-OSEM in the field of SPECT has been reported (7-10). Although the effect using 3D-OSEM in MPS has not been confirmed yet, the combination of the sensitive gamma camera and the high quality correction method are expected to produce superior diagnostic imaging. However in our study, the perfusion count reduction in 3D-OSEM reconstruction becomes more prominent than in FBP. It is possible that the contrast improvement would emphasize the accumulation difference more, and low perfusion count regions in FBP would be expressed as lower perfusion. Furthermore, in 3D-OSEM the lateral wall was assessed lower than in FBP, and we don’t have a clear explaining for this result yet. However it has been reported that the high spatial resolution application may have the ability to separate inferior wall from adjust bowel uptake (6). Therefore other studies will be needed to assess the diagnostic value of 3D-OSEM in MPS.
may be effective in revealing the overall benefits of SSPAC higher.

**Conclusion**

With the use of GCA-9300R, the perfusion count tends to become lower in the inferior and septal area, especially in male cases. The normal perfusion count is matched with the feature of 360° rotation acquisition reported in past. When we conduct MPS using GCA-9300R, we should take care of the perfusion count reduction in the septal, lateral and apical region with 3D-OSEM, especially in male case. In combination with SSPAC, the count reduction in septal and inferior regions and the count elevation in lateral wall could be corrected, and we could get more precise image to make a more accurate diagnosis.

**Acknowledgments**

None.

**Sources of funding**

None.

**Conflicts of interest**

None.

Reprint requests and correspondence:

Jumpei Suyama, MD, PhD
Shonan University of Health Sciences. Faculty of Health Sciences, 14-48 Ueshinano, Totuka-ku, Yokohama 244-0806 Japan
E-mail: jcarl_s@hotmail.com

---

**References**

1. Fricke H, Fricke E, Weise R, et al. A method to remove artifacts in attenuation-corrected myocardial perfusion SPECT Introduced by misalignment between emission scan and CT-derived attenuation maps. J Nucl Med 2004; 45: 1619-25.

2. Segall GM, Davis MJ. Prone versus supine thallium myocardial perfusion SPECT: a method to decrease artifactual inferior wall defects. J Nucl Med 1989; 30: 548-55.

3. Hayes SW, De Lorenzo A, Hachamovitch R, et al. Prognostic implications of combined prone and supine acquisitions in patients with equivocal or abnormal supine myocardial perfusion SPECT. J Nucl Med 2003; 44: 1633-40.

4. Nakajima K, Kumita S, Ishida Y, et al. Creation and characterization of Japanese standards for myocardial perfusion SPECT: database from the Japanese Society of Nuclear Medicine Working Group. Ann Nucl Med 2007; 21: 505-11.

5. Nishina H, Slomka PJ, Abidov A, et al. Combined supine and prone quantitative myocardial perfusion SPECT: method development and clinical validation in patients with no known coronary artery disease. J Nucl Med 2006; 47: 51-8.

6. Grünig T, Jones IW, Heales JC. Efficacy of various SPECT reconstruction algorithms in differentiating bowel uptake from inferior wall uptake in myocardial perfusion scans. Nucl Med Commun 2013; 34: 113-6.

7. Yokoi T, Shinohara H, Onishi H. Performance evaluation of OSEM reconstruction algorithm incorporating three-dimensional distance-dependent resolution compensation for brain SPECT: a simulation study. Ann Nucl Med 2002; 16: 11-8.

8. Sheehy N, Tetrault TA, Zurakowski D, et al. Pediatric 99mTc-DMSA SPECT performed by using iterative reconstruction with isotropic resolution recovery: improved image quality and reduced radiopharmaceutical activity. Radiology 2009; 251: 511-6.

9. Stansfield EC, Sheehy N, Zurakowski D, et al. Pediatric 99mTc-MDP bone SPECT with ordered subset expectation maximization iterative reconstruction with isotropic 3D resolution recovery. Radiology 2010; 257: 793-801.

10. Kalantari F, Rajabi H, Ay MR, et al. The influence of resolution recovery by using collimator detector response during 3D OSEM image reconstruction on 99mTc-ECD brain SPECT images. Hell J Nucl Med 2012; 15: 92-7.

11. Yamauchi Y, Kanzaki Y, Otsuka K, et al. Novel attenuation correction of SPECT images using scatter photopeak window data for the detection of coronary artery disease. J Nucl Cardiol 2014; 21: 109-17.

12. Okuda K, Nakajima K, Motomura N, et al. Attenuation correction of myocardial SPECT by scatter-photopeak window method in normal subjects. Ann Nucl Med 2009; 23: 501-6.