

고감도 범용성 콜리메이터를 이용한 소아 환자 ^{99m}Tc -DMSA 신장 SPECT의 유용성

Clinical Usefulness of ^{99m}Tc -DMSA Renal SPECT Using High Sensitivity-All Purpose Collimator for Pediatric Patients

김진의*, 김정수**, 한재복*, 최남길*
동신대학교 방사선학과*, 동남보건대학교 방사선과**

Jin-Eui Kim(kim20425@daum.net)*, Jung-Soo Kim(essencekim@dongnam.ac.kr)**,
Jae-Bok Han(way2call@naver.com)*, Nam-Gil Choi(crs723@hanmail.net)*

요약

신장의 기능을 정량분석 할 수 있는 ^{99m}Tc -DMSA 평면 영상은 단층영상에 비해 병소의 위치 정보에 한계가 있다. 따라서 광자 신호에 민감한 범용성 collimator로 교체하여 SPECT 방식으로 임상실험을 시행한 후, 진단의 정확도와 검사 소요시간을 분석하여 임상적용 가능성을 평가하였다. 10명의 실험대상에게 방사성의약품(1.0-1.2 MBq/kg)을 정맥주사하고, 이중 검출기 감마카메라를 이용하여 planar scan (high resolution (HR)-mode, 256×256, 50 kcts/view, 4 image)과 SPECT (HR / high sensitive (HS)-mode, 128×128, step and shoot, 180°, variable sec/angle, total 64 frame, OSEM reconstruction)를 시행하였다. 획득한 데이터를 분석 프로그램을 이용하여 비교한 결과, 실험 방법에 따라서 total counts는 high sensitive-mode SPECT가 대략 1.8-5.6 배 정도 많았고, counts를 이용한 상대신장기능은 모든 실험에서 유의한 수준 범위에서 차이가 없었으며($p=0.96$), 검사 소요시간은 39%정도 단축되었다. 그러므로 고감도 범용성 collimator를 이용한 ^{99m}Tc -DMSA renal SPECT는 planar scan에 비하여 신장의 기능을 정량분석 할 수 있고, 병변의 위치에 대한 정보를 보다 정확하게 진단할 수 있으며, 동시에 검사 소요시간을 단축시킬 수 있으므로 임상적으로 유용하게 활용할 수 있을 것으로 사료된다.

■ 중심어 : ^{99m}Tc -DMSA | SPECT | 고감도 콜리메이터 | 상대신장기능 |

Abstract

^{99m}Tc -DMSA planar scan that can analyze the functions of kidney quantitatively provides less information on a lesion than tomography scanning. Therefore, this study applied a high sensitivity all-purpose collimator that is sensitive to photonic signals to ^{99m}Tc -DMSA and carried out a clinical scan with single photon emission computed tomography (SPECT). And diagnostic accuracy and time requirement of were analyzed to know the clinical usefulness of the applied scanning method. 10 subjects were intravenously injected with radiopharmaceutical product (1.0-1.2 MBq/kg) and scanned by a gamma camera with planar scanner (high resolution (HR)-mode, 256×256, 50 kcts/view, 4 image) and SPECT (HR / high sensitive (HS)-mode, 128×128, step and shoot, 180°, variable sec/angle, total 64 frame, OSEM reconstruction), respectively. The collected data was compared with an analysis program. The results showed that HS-mode SPECT detected total counts 1.8-5.6 times more than planar scan. Relative renal function evaluated based on the counts was not significantly different by two scanning methods ($p=0.96$) and it turned out that test time was shortened by 39% when HS-mode SPECT was used. Therefore, SPECT using HR, HS-mode collimator could analyze renal function more quantitatively than using planar scan and the former could diagnose the location information of a lesion more accurately than the latter as well as shortened test time requirement, which demonstrated the clinical usefulness of ^{99m}Tc -DMSA renal SPECT using high sensitivity all purpose collimator.

■ keyword : ^{99m}Tc -DMSA | SPECT | All Purpose Collimator | Total Relative Uptake Ratio |

I. Introduction

^{99m}Tc -DMSA (dimercaptosuccinic acid) is fixed to renal tubule through glomerula filtration and secretion and ingestion in renal tubule, so it can measure renal parenchyme. Renal tubular acidosis and proximal tubule dysfunction are closely related with glomerula filtration rate or renal plasma flow in general, except the treatment of gentamycin or cisplatin. It can be used to diagnose inflammation or tumor in kidney because it is not secreted in kidney well and so high quality images of renal cortex is acquired[1-3].

^{99m}Tc -DMSA is a radiopharmaceutical product that can yield very satisfactory images of kidney cortex and thus provides the biological information of renal functions. Therefore, using ^{99m}Tc -DMSA, we can know the degree of blood flow disorder and functional impairment before it develops to tissue damage. ^{99m}Tc -DMSA is ingested in kidney cortex and the ingestion rate with medulla is 22:1. Most of ^{99m}Tc -DMSA is also ingested in proximal tubule cytoplasm of the cortex. ^{99m}Tc -DMSA ingestion is highly corrected with creatinine, hippuran, and ^{99m}Tc -DTPA clearance, but can vary by acid-base state, diseases in proximal tubule, or use of medicine. Therefore, it does not necessarily reflect functional renal parenchyme, glomerular filtration rate, or effective renal plasma flow. Although ^{99m}Tc -DMSA meets optimal conditions for nuclear medicine test, being able to provide renal parenchyme images, it has some obstacles to application: low radiochemical stability is low, potentially low ingestion in kidney, overestimation of renal function, no image acquisition of urinary organs other than kidney and high radiation dose due to high cortex ingestion[4-7]. Therefore, SPECT replacing planar scan is recommended because it can detect linear shaped functional parenchymal defect or interrenicular

septum from renal hilus and renal parenchyme and delicately measure the size, outline and shape of kidney, distinguishes between cortex and medulla, and diagnose defect region of cortex and relative functional ratio of left and right kidney[Fig. 1][8][9].

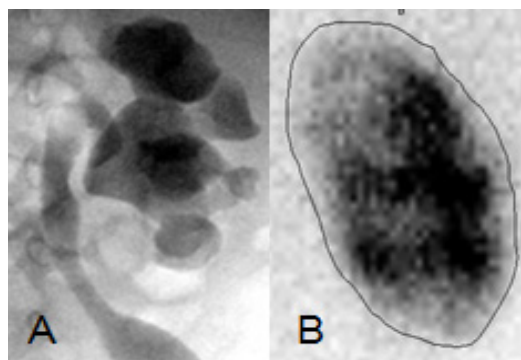


Fig. 1. A; Voiding cystourethrography demonstrates bilateral grade V reflux. B; ^{99m}Tc -DMSA renal cortical scan demonstrates multiple bilateral peripheral photopenic defects.

However, because SPECT has to obtain information of kidney from every angle and recombine images, test time requirement is naturally long, so it is not clinically useful for unconscious patients or pediatric patients. The clinical effectiveness of kidney SPECT has not been much studied yet, but it was reported that SPECT has increased sensitivity to kidney cortex defect[10-13]. Therefore, the present study compared the accuracy of relative renal function detected by SPECT equipped with high resolution collimator and existing planar scan, measured test time required to determine the possibility and usefulness of renal SPECT for clinical purpose.

II. Materials and Methods

1. Subjects

Using 10 normal pediatric patients who volunteered

for the study (6 males, 4 females), the study was conducted from March to April, 2015. Average age was 6.45 ± 1.84 years and average height was 112.2 ± 9.31 cm, with average weight being 21.7 ± 5.87 kg. Given the characteristics of the experiment, those with a history of renal diseases including acute renal failure, renal transplantation, renal inflammation were excluded from the subjects. The glucose level of all participants were lower than 120 mg/dl and blood pressure lower than 140/70 mmHg. The samples with diabetes were excluded from the experiment and only those who were in the range of BST (blood sugar exam) 80-120 mg/dl and BMI (body mass index) 18.5-22.9 were selected. Before the experiment, subjects were banned from drinking caffeine or vitamin and sufficient rest was recommended to maintain a stable level of renal function[14].

2. Radiopharmaceuticals

A radiopharmaceutical product was produced by labeling ^{99m}Tc and DMSA kit vial (Fuji film RI pharma Co. Japan), which are manufactured by ^{99}Mo - ^{99m}Tc generator (Mallinckrodt, Ireland). And then it (1.0-1.2 MBq/kg) was intravenously injected to the test subjects in accordance with EANM (European Association of Nuclear Medicine) guideline[15]. After injection, 40% of the radiopharmaceutical product is ingested in kidney cortex and none is ingested in renal meauilla or collecting tubes. Because ^{99m}Tc -DMSA reacts with oxygen and its original property changes, which results in decreasing ingestion in kidney but increasing ingestion in liver, measurement had to be taken within 30 minutes after the injection[16]. While keeping constant the distance between the gamma camera detector and the test table for accurate quantitative analysis on kidney ingestion rate and functions, this study measured the radiation in the

injector of the radiopharmaceutical product before and after injection and calculated accurate dose.

3. Equipments

Dual head gamma camera (E.cam signature, Siemens, Germany) was used to perform planar scan and SPECT. A high resolution (HR) collimator was installed to the planar scan according to the existing test protocol[Fig. 2].

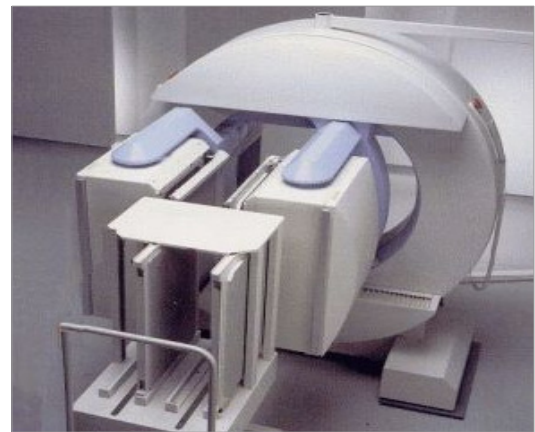


Fig. 2. Exchange for 2 type of collimator (high resolution (HR) / high sensitivity (HS) all purpose), Dual head gamma camera-SPECT E.cam signature (Siemens, Germany)

A collimator is a part of gamma camera made of lead. It can select only images worth being data from gamma ray images that are of directional property but generally in disorder due to such physical and geometric factors as the thickness of the partition wall (distance between holes) and the thickness of the collimator (length of a hole). Collimator can be divided into 2 categories: one with low sensitivity and long scan time, but excellent spatial resolution and the other with short scan time but low spatial resolution[Fig. 3][16].

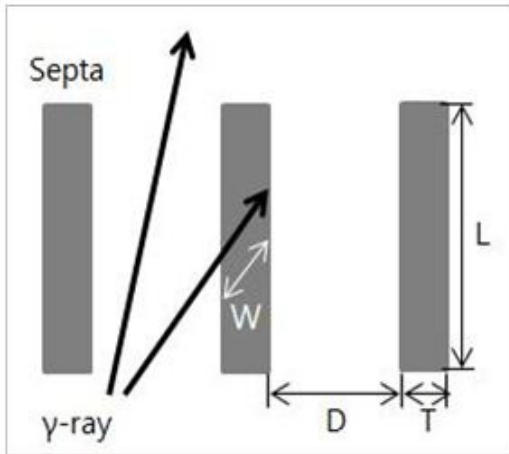


Fig. 3. The diagram shows a γ -ray following the exam path (W) through the septa. (L; septal length, T; septal wall thickness, D; septal width)

The principle of the SPECT is to rotate the object and add all the signals acquired at all angles for a certain duration of time. Then through a calculation, the image is recomposed in order to offer information on depth. The total exam duration can be adjusted by adjusting the time acquired at each angle. In accordance with the counts measured at the minimum acquisition time of the equipment used, it was set at low counts mode to conduct the experiment for a minimum amount of time. The existing SPECT duration, which is in accordance with the guideline recommended by EANM[15].

4. Methods

While keeping constant the distance between the gamma camera detector and the test table for accurate quantitative analysis on kidney ingestion rate and functions, this study measured the radiation in the injector of the radiopharmaceutical product before and after injection and calculated accurate dose. And then ^{99m}Tc -DMSA, which was the radiopharmaceutical product to be injected into the

test subject, was extracted into 1 cc syringe and set on the test table. And then, considering the linearity of the equipment, radioactive coefficient was measured for a minute before injection while the syringe remained still 27 cm from the detector [Fig. 4].

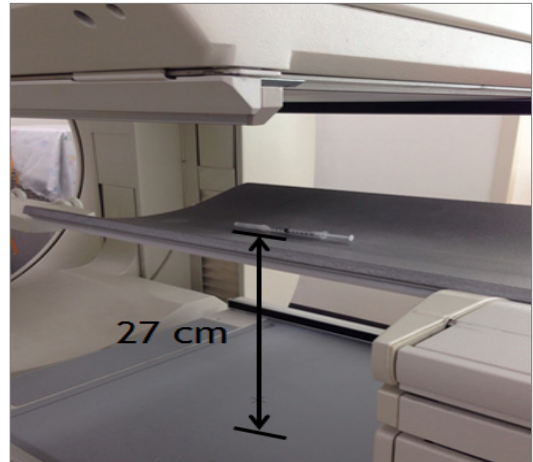


Fig. 4. ^{99m}Tc -DMSA was extracted into 1 cc syringe and set on the test table. And then, considering the linearity of the equipment, radioactive coefficient was measured for a minute before injection while the syringe remained still 27 cm from the detector.

The radiopharmaceutical product was intravenously injected in the right arm of an individual test subject. After injection, the radioactive coefficient in the syringe was measured in the same manner as before to confirm actual injection dose. At this time, injection time and height and weight of the test subjects were also recorded. Based on this information, attenuation correction and tracer product correction were carried out together, considering the depth of kidney, which is different by individual physical constitution. 2 hours after the injection of the tracer product, the test subjects were asked to urinate to empty their bladders and lie back on the test table with both arms held out to get pressed against the detector with a

HR collimator. POST (posterior view) of both kidneys was scanned at 256×256 matrix, 1.0 magnification, and 50 kcounts. Under the same time condition as scanning the posterior view, ANT (anterior view), LPO (left posterior oblique view), and RPO (right posterior oblique view) were scanned with planar scan in the order. When planar scanning completed, an HS collimator was placed instead to the detector. Without waiting time, the test subjects still lying on the table were scanned for SPECT at 128×128 matrix, step and shoot mode, non-circular orbit, 180° rotation, counterclockwise direction, body contour and 7 kcounts/angle, total 64 frame acquisition mode. The collected SPECT data were recomposed in OSEM (ordered-subsets expectation maximization), setting a number of iteration to 6 and maximum number of subset to 8. At this time, frequency was set to 0.48 and butter-worth post filter was used. Scatter correction was also applied simultaneously[Fig. 5].

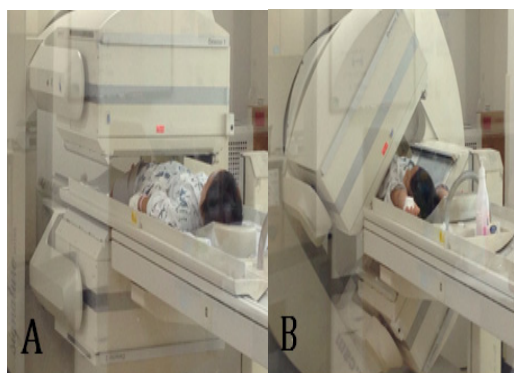


Fig. 5. A; Planar scan, B; SPECT. 2 hours after the injection, the test subjects were asked to urinate to empty their bladders and lie on back on the test table with both arms held out. At this position, they were scanned with planar scan (POST, ANT, LPO, RPO) and SPECT.

5. Quantitative Analysis

With the region of interest (ROI) of left and right kidney and background set equal on ANT and POST kidney data acquired from renal planar scan, each count of them was measured. Because it has been reported that when planar scan is used, it is better to use geometric mean in case that there is difference in depth such as ectopic kidney and deformed chest wall than arithmetic mean, this study used the coefficients of ANT and POST to calculate geometric mean, which was to maintain the accuracy of measuring relative function by difference in depth[Fig. 6][18].

$Total\ counts(Ant, Post) =$

$$kidney\ counts - \left\{ \left(\frac{BKG\ counts}{BKG\ area} \right) \times kidney\ area \right\}$$

$Total\ LT: RT\ uptake(\%) =$

$$\left\{ \frac{\sqrt{each\ kidney(Ant) \times (Post)}}{(\sqrt{LT(Ant) \times (Post)} + \sqrt{RT(Ant) \times (Post)})} \right\} \times 100$$

* LT; left, RT; right

Fig. 6. The region of interest of kidney was set and counts were measured using geometric mean. Total relative kidney ingestion rate was calculated to evaluate the functions.

As for SPECT images, The same ROI as planar scan was set on the images acquired from the summed coronal plane data and total counts were calculated to produce for mean[Fig. 7].

ROI was not set automatically but by experienced an image specialist. ROI was manually set on two even spots of kidneys, not overlapping bladder and also not deviating from the kidney surface[Fig 8].

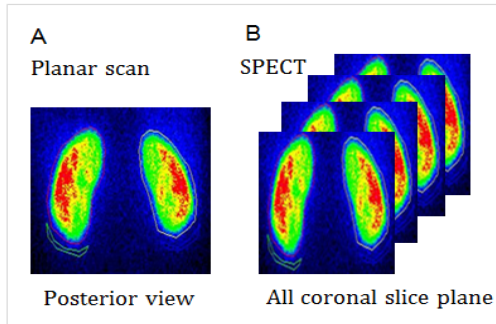


Fig. 7. A; After setting the same region of interest on ANT and POST kidney data acquired from renal planar scan, each count of them was measured. B; As for SPECT images, The same ROI as planar scan was set on the images acquired from the summed coronal plane data and total counts were calculated to produce for mean.

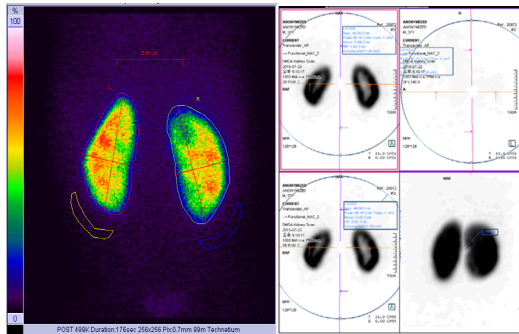


Fig. 8. Workstation was used to quantitatively analyze the entire counts acquired from all the experiments of this study.

6. Statistical Analysis

To objectify the correlation between the experimental data, descriptive statistic analysis was carried out using arithmetic, geometric mean and standard deviation. Parametric ANOVA (analysis of variance) test, which is one of inferential statistics, was applied and significant difference was confirmed ($\alpha=0.05$; significance level of 95%, $p > 0.05$). SPSS ver. 20 (IBM Inc. US) program was used for all the experimental data.

III. Results

As specified in the existing test protocol, planar scan equipped with HR collimator produced 4 images (ANT, POST, LPO and RPO). Of them, ROI was set on both kidneys in ANT and POST image data and each count were measured to calculate geometric mean. And then the counts of LT, RT kidney were compared. As for SPECT, it was installed with HR, HS collimator and produced images. The raw image data were reconstructed and the entire sagittal planes were summed. The same ROI was set on both kidneys on the reconstructed image. And then the counts of LT, RT kidney were compared. The comparison showed that planar scan had the mean of total counts of left kidney (139.7 kcounts) and right kidney (147.3 kcounts), HR-mode SPECT had the mean of total counts of LT kidney (409.3 kcounts) and RT kidney (436.3 kcounts) and HS-mode SPECT had the mean of total counts of LT kidney (748.6 kcounts) and RT kidney (787.9 kcounts)[Table 1]. In addition, both scanning methods didn't show significant difference in background counts measured after setting ROI around both kidneys ($P=0.69$). It was known that the scan methods are not a factor to have impact on results[Table 2].

According to the principle of photon acquisition, SPECT had more counts than planar scan because the former acquires photon signals at every direction while the latter does so in one direction for a certain time period. of SPECT with different collimators, SPECT with HS collimator acquired most counts because it is most sensitive to such geometric features of a collimator as septal length, septal wall thickness, and septal width. In other words, it is thought that SPECT with high sensitivity collimator has the most signal source that determines the quality of image for nuclear medicine imaging reconstruction[Fig. 9][19].

Table 1. Total acquisition both kidney geometric counts of all experiments

Vol.	Planar scan (HR mode)		SPECT (HR mode)		SPECT (HS mode)	
	LT	RT	LT	RT	LT	RT
1	132	138	399	425	694	725
2	127	132	377	387	677	689
3	76	169	235	512	415	921
4	162	141	481	424	866	751
5	138	139	411	421	788	792
6	145	171	415	495	768	923
7	142	158	418	457	751	838
8	189	181	541	531	1018	952
9	158	102	438	287	834	543
10	128	142	378	424	675	745
Ave.	139.7	147.3	409.3	436.3	748.6	787.9
SD	±29.27	±23.07	±78.83	±69.88	±156.48	±125.75

*HR: high resolution, HS: high sensitivity

Table 2. Total acquisition both background counts of all experiments

Vol.	Planar scan (HR mode)		SPECT (HR mode)		SPECT (HS mode)	
	LT	RT	LT	RT	LT	RT
1	1.10	1.10	1.20	1.10	1.20	1.20
2	1.10	1.00	1.10	1.10	1.00	1.10
3	1.20	1.10	1.10	1.00	1.20	1.10
4	1.10	1.20	1.10	1.20	1.20	1.20
5	1.10	1.10	1.10	1.10	1.20	1.10
6	1.00	1.10	1.10	1.10	1.10	1.20
7	1.20	1.10	1.20	1.10	1.30	1.20
8	1.10	1.10	1.10	1.10	1.20	1.10
9	1.20	1.20	1.20	1.10	1.20	1.20
10	1.10	1.00	1.10	1.00	1.20	1.10
Ave.	1.12	1.10	1.13	1.09	1.18	1.15
SD	0.06	0.06	0.04	0.05	0.07	0.05

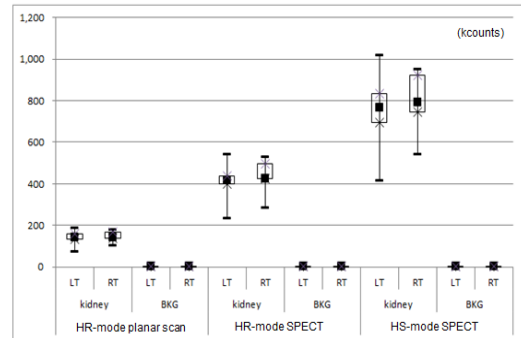


Fig. 9. The counts acquired by HS-mode SPECT were 5.34 times greater than those by HR-mode planar scan.

After measuring and analyzing the ingestion rate of radiopharmaceutical product - that is, the counts of photon emitted from both kidneys-, this study used the data to analyze relative renal function ratio, which indicates renal function. It turned out that, by scanning method, the average ratios of left kidney to right kidney were 48.45:51.55 (HR-mode planar scan), 48.31:51.69 (HR-mode SPECT), and 48.53:51.47 (HS-mode SPECT)[Table 3].

Table 3. Comparison of relative renal function ratio by scanning methods

Vol.	Planar scan (HR mode)		SPECT (HR mode)		SPECT (HS mode)		SD
	LT	RT	LT	RT	LT	RT	
1	48.94	51.06	48.42	51.58	48.90	51.10	±0.28
2	49.04	50.96	49.34	50.66	49.56	50.44	±0.26
3	30.93	69.07	31.45	68.54	31.06	68.94	±0.27
4	53.46	46.54	53.14	46.86	53.55	46.45	±0.21
5	49.68	50.32	49.39	50.61	49.87	50.13	±0.24
6	45.88	54.12	45.61	54.39	45.41	54.59	±0.23
7	47.33	52.67	47.77	52.23	47.26	52.74	±0.27
8	51.08	48.92	50.46	49.54	51.67	48.33	±0.60
9	60.76	39.24	60.41	39.59	60.56	39.44	±0.17
10	47.40	52.60	47.13	52.87	47.53	52.47	±0.20

In addition, all the test results from the quantitative analyses in this study did not yield statistically significant difference in on renal functions by scanning method ($p=0.96$). That is, it indicates that those scanning methods attempted in this study can produce reliable scanning outcomes while maintaining image quality because they had detected no less than or more counts of photon, by which renal functions can be evaluated, than existing test methods. Therefore, it can be considered that they are suitable for clinical use because their diagnostic value was intact or better than existing ones[Fig. 10][20-22].

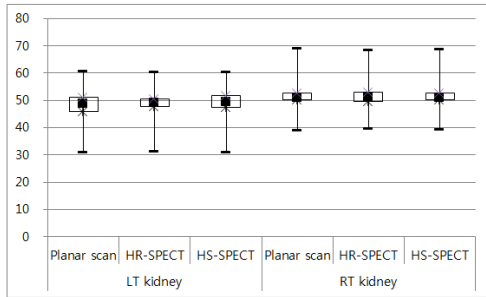


Fig. 10. Results from the quantitative analysis on renal functions were not significantly different by experimental methods.

Renal planar scan is the aggregate time of all durations for the 4 times of 2 dimensional scans, while for the SPECT it is the time it took to rotate 360°. According to the characteristics of each collimator, the time for acquiring an imaging signal at each angle were input in advance. For planar scan, total testing time taken to acquire 4 image data were calculated. In case of SPECT, total testing time during which two detectors acquire photon signals at each angle while rotating from 0° to 360° was summed. The testing times were compared. To perform scanning on 10 test subjects, it take planar scan 1141.9(±224.65) sec/mean; HR-mode SPECT 1363.5(±248.39) sec/mean,; and HS-mode SPECT 99.1(±105.6) sec/mean[Table 4].

Table 4. Total acquisition time of all experiments with different collimators

Vol.	Planar scan (HR mode)				Total	SPECT-	SPECT-
	POST	ANT	LPO	RPO		(HR)	(HS)
1	279	265	335	335	1186	1344	672
2	238	226	286	286	1036	1284	642
3	176	167	211	211	765	942	544
4	322	306	386	386	1400	1588	802
5	256	243	307	307	1113	1350	687
6	324	308	389	389	1410	1678	846
7	308	293	370	370	1341	1586	789
8	186	177	223	223	809	985	546
9	284	270	341	341	1236	1532	788
10	258	245	310	310	1123	1346	675
Ave.	263.1	250.0	315.8	315.8	1141.9	1363.5	699.1
SD	51.76	49.26	62.20	62.20	224.6	248.3	105.6

Therefore, the testing time of HR-mode SPECT was 1.19 times shorter and HS-mode SPECT, which is the main research object, 1.94 times shorter than planar scan. As explained before, SPECT scanning methods (HR-mode and HS mode) used high resolution collimator to obtain photon signals for 4 images in every direction, so could shorten testing time more than planar scan that acquired the signals only in one direction. Therefore, time efficiency of HR-mode and HS mode SPECT scanning methods were verified[Fig. 11][23][24].

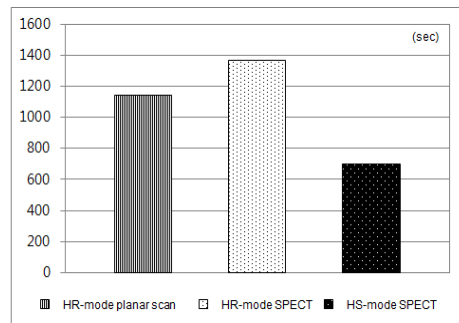


Fig. 11. Acquisition time of all experiments with different collimator. Consideration standard experiment is planar scan and comparative SPECT, the meaning of reduced time is significant.

Moreover, when the diagnostic value of planar scan and two type-mode SPECT scanning were evaluated, all SPECT scanning could more easily detect a lesion on 6 test subjects who showed abnormal ingestion out of 10 participants than planar scan. Judging from bare-eye evaluation, the image quality of HR-mode SPECT was the best, but HS-mode SPECT was not also significantly different from HR-mode SPECT in terms of sensitivity, accuracy and specificity, which determine the diagnosis of a lesion. Therefore, HS-mode SPECT was considered as most suitable for clinical use because it had shorter testing time than planar scan, detected enough counts of photon, was significantly similar in relative renal function ratio, and was better in locating a lesion[Fig. 12][25].

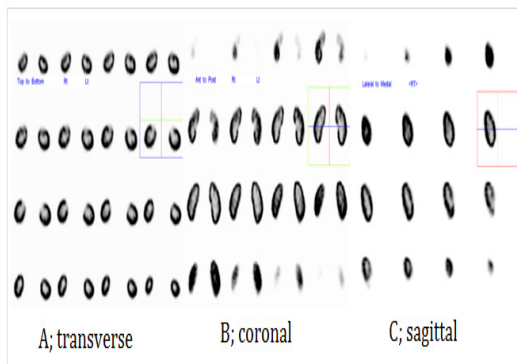


Fig. 12. ^{99m}Tc -DMSA renal scan showed evidence of cortical portion in SPECT transverse, coronal, sagittal plane imaging A, B, C

IV. Discussion

As the equipment for nuclear medicine has developed, it became possible to acquire high resolution and image contrast of SPECT images using a multiple detector; measure cortex thickness; know the relationship between cortex and medulla; identify minor and local lesion and precisely diagnose

the location in 3D. Furthermore, a study reported said that because there is correlation between the ingestion rate of ^{99m}Tc -DMSA SPECT image and serum creatinine and creatinine clearance rate, it can be used as an indicator to renal function[26-28]. According to several reports, SPECT 3D images are better than ^{99m}Tc -DMSA planar scan in detecting the cortex ingestion defect of children with pediatric urinary tract infection[28], the former showed 30% improvement in diagnostic sensitivity[30]. According to similar studies, SPECT images with trans axial, coronal and sagittal plane and SPECT with 3D images that were reconstructed by computer found more lesions in kidney by 21% and 30%, respectively, than planar image[31]. In an animal test (pig), when kidney infection was artificially triggered, it was reported that planar image detected 43% of cortex ingestion defect while ^{99m}Tc -DMSA SPECT found 97%[32]. In addition, domestic studies also observed that the detection rate of the lesion of cortex ingestion defect by planar image was 21.1% while it was 32.9% by SPECT images. And all the cases that planar image determined positive diagnosis were confirmed to have ingestion defect or more lesions of cortex ingestion defect by SPECT images[25]. However, ^{99m}Tc -DMSA SPECT image scanning has also weakness: the possibility of misdiagnosis such as false negative rate and false positive rate, impact of unnecessary artifact on image; and no presence of clinoco-pathological indicators to kidney impairment. Therefore, it is necessary to establish clinical judgment to overcome those technical issues. For these reasons, some oppose the usefulness of SPECT 3D images. However, the recent development of dynamic SPECT 3D image technology using software allowed high resolution images. However, it still requires more studies to determine the usefulness of SPECT 3D images for clinical purpose[17].

In addition, More clinical studies will be required to generalize the results because the study subjects were relatively small of 10 subjects and they are not the serious patients who cannot urinary function but the normal people. Additionally and in clinical tests, dosage of radiopharmaceutical should be applied according to the each sites, because the functions of SPECT equipments and collimators are different according to the manufacturers and dosage of tracer that patients injected has the differences in individual institutions. Objective of this study was to identify the significance of renal static planar scan results according to the characteristic of collimator and the correlations with time reduction, in the process of finding hardware methods in order to reduce examination times of renal SPECT. If the software like image processing and half time methods (Onco. Flash, Astonish, evolution) can be provided by the manufacturer and additional tests are performed, interesting results are expected and therefore additional studies are considered to be performed in the future. Additionally, recent technologies which enable consecutive capturing SPECT and CT images and subsequent fusion or registration provide the methods to compare and read the images more accurately and conveniently which are the current trends, and therefore, additional studies will be required.

V. Conclusion

This study examined the applicability of SPECT to clinical setting by analyzing and comparing the accuracy of renal planar scan and SPECT by collimator mode. In case that normal test is not allowed by the conditions of a patient such as young child patient, emergency patient and/or patient in

serious condition and test should be done in a short time period, SPECT with high resolution, high sensitivity collimator can make up for the low count rate caused by radiopharmaceutical product ingestion rate of kidney; detect more total counts of raw data; identify the location of a lesion more accurately; analyze the collected data from kidney more quantitatively at due significance level; and shorten testing time than planar scan. Therefore, it can reduce the chance of wrong diagnosis on patient's conditions due to patient's artifact and motion blurring by long test and even provide more accurate medical information on the area where existing planar scan can't reach. In conclusion, ^{99m}Tc -DMSA renal SPECT is more useful scanning method than planar scan in diagnosing, identifying, and determine the initial kidney lesion of young child. By detecting cortex ingestion defect at early stage, it can prevent kidney damage and help decide tracking check.

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저 자 소 개

김 진 의(Jin-Eui Kim)

준회원



- 2014년 3월 ~ 현재 : 동신대학교 대학원 방사선학과 석사과정
- 1992년 3월 ~ 현재 : 서울대학교병원 핵의학과

<관심분야> : 핵의학, 방사선물리

김 정 수(Jung-Soo Kim)

정회원



- 2003년 3월 ~ 2014년 : 서울대학교병원 핵의학과
- 2014년 8월 : 고려대학교 의학물리학과(이학석사)
- 2015년 3월 ~ 현재 : 고려대학교 의학물리학과(박사과정)

▪ 2015년 3월 ~ 현재 : 동남보건대학교 방사선과 교수
<관심분야> : 의학물리, 분자영상

한 재 복(Jae-Bok Han)

정회원



- 2003년 2월 : 호남대학교 컴퓨터공학과(공학사)
- 2007년 2월 : 전남대학교 전자공학과(공학석사)
- 2013년 8월 : 전남대학교 전자공학과(공학박사)

▪ 2009년 ~ 현재 : 동신대학교 방사선학과 교수
<관심분야> : 객체분할, 의료영상압축

최 남 길(Nam-Gil Choi)

정회원



- 1989년 8월 : 조선대학교 대학원 화공식품전공(공학석사)
- 2009년 8월 : 동신대학교 대학원 방사선물리학과(이학박사)
- 1980년 ~ 2010년 : 전남대학교 병원 영상의학과

▪ 2011년 3월 ~ 현재 : 동신대학교 방사선학과 교수
<관심분야> : 보건통계, 방사선물리