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Assessment the intrarenal focal lesions using bone tracer ^{99m}TC-MDP compared with renal cortical imaging agent ^{99m}TC-DMSA

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Abstract: *Static renal scintigraphy with Tc-99m dimercaptosuccinic acid (DMSA) is considered a reference method for assessment the intrarenal focal lesions. The aim of this study was to evaluate Tc-99m methylene diphosphate (MDP) static scintigraphy for the same purpose. 23 patients (6 males, 17 females) with range age of 16y -75y (mean 45.6y ± 17.4y), submitted to both methods (by using both tracers ^{99m}TC-DMSA and ^{99m}TC-MDP) from May 2014 to june 2015 for detecting intrarenal focal lesions. ^{99m}TC-DMSA images were compared with images by bone seeking radiopharmaceutical ^{99m}TC-MDP. A cold area without uptake was demonstrated on late images, reflecting a non-functioning renal mass. Kidney morphology was independently evaluated by 2 observers. The results showed that sensitivity, specificity and accuracy rates for ^{99m}TC-MDP in detecting intrarenal focal lesions were calculated to be 100%, 71% and 78% for left kidney and 100%, 68% and 74% for right kidney, respectively.*

Keywords: *Intrarenal focal (cortical) lesions, ^{99m}TC-methylene diphosphate (^{99m}TC-MDP), ^{99m}TC-dimercaptosuccinic acid, (^{99m}TC-DMSA).*

I. Introduction

Functional and morphological investigations with radionuclides play a prominent role in the diagnostics and follow up of various kidney diseases[1,2]. ^{99m}TC-DMSA is an excellent agent for detecting focal abnormalities of the renal cortex, because of its high kidney uptake. The disappereance rate of DMSA from the circulation is very slow, because it is tightly and almost completely bound to plasma proteins. So, ^{99m}TC-DMSA scintigraphy is considered the most sensitive method to prove existence of parenchymal damage due to acute or chronic pyelonephritis[3,4]. A kidney with regular shape and a tracer uptake that appeared to be homogenous was considered as normal. Single or multiple cortical defects, focal or diffuse photopenic patterns in one kidney were considered as abnormal[5,6].

Bone scintigraphy is a useful examination for the clinical diagnosis, especially in evaluating and following up the status of cancer patients with suspicious bony metastasis, but many authors found that there are a number of renal disorders detected while doing bone scintigraphy because ^{99m}TC-MDP is excreted through the kidneys to provide adequate visualization of the urinary tract, and **Michael**[7] reported that Techetium-99m-phosphate compounds used in bone scanning are excreted by the kidney, and excellent renal images can be obtained on routine bone scintigraphy. Furthermore, damage to the kidney is caused by chemotherapy and/ or radiation therapy when the kidneys are included in the radiation field[8]. Therefore, the visualization of cortical focal lesions as well as the detection of bone metastases is useful in patients that received radiation therapy for detecting undermine renal disorders, and prevent going to irreversible stage of renal damage.

II. Material and methods

Subject :-

Between may 2014 and june 2015, 23 patients (within ages ranged from 16years -75years old) who had undergone ^{99m}TC-DMSA and ^{99m}TC-MDP scintigraphy in Nuclear Medicine division – Radiology department, Zagazig University Hospital, (Egypt). Because of various renal disorders and for routine indications, evaluation intrarenal focal lesions using both ^{99m}Tc-MDP(methylene diphosphate) and ^{99m}Tc DMSA (dimercaptosuccinic acid) scintigraphy. All 46 studies were performed using both radionuclides for each patient to evaluate the usefulness of bone tracer in detecting renal abnormalities as compared with renal cortical agent. All radionuclide studies were carried out using a Dual-headed gamma camera equipped with a low-energy, high-resolution parallel-hole collimator (GE Healthcare Unveils Discovery NM 630 SPECT). During imaging, the collimator was set as close as possible to the patients.

^{99m}TC-DMSA Scintigraphy :-

^{99m}TC-DMSA study had been requested first when intrarenal focal lesions were suspected in patients with urinary tract infection. There is no preparation for patients during a DMSA Scan, they can eat and drink normally. The radiopharmaceutical was prepared according to the manufacturer's instruction with the kit.

Patients were injected with activity 5.0 mci of the radiopharmaceutical followed by infusion of 20 ml of normal saline. After 2–3 hours intravenous injection, ^{99m}Tc-DMSA static cortical images were acquired in 256 x 256 matrix for each patients in a supine position that appears the best position to minimize renal depth difference, thus improving the accuracy of cortical imaging and with gamma camera's detectors placed in a posterior and anterior, right and left posterior oblique views (250 kcounts / view or 5 minutes / view).

^{99m}TC-MDP Scintigraphy :-

^{99m}Tc-MDP Static cortical images were performed in another day, for comparison with ^{99m}Tc-DMSA Static cortical images for the same patients. Data collection and analysis were repeated under the same conditions, and observers check all images to detect intrarenal focal lesions by two tracers.

Data Analysis :-

Using the posterior and anterior digital images, regions of interest are placed around both kidneys and background drawn below both kidneys . Then, the observers check the contours of kidneys in all images by using two tracers to assessment the efficacy of ^{99m}TC-MDP in detecting intrarenal focal lesions as compared with cortical images by using ^{99m}TC-DMSA. Comparison of focal lesions analyses was performed using Chi-squared test.

III. Results

The results of assessment of cortical defect showed that intrarenal focal lesions associated with the left kidneys greater than the right kidneys, and normal cases in 52% of left kidney and 57% of right kidney as shown in (**Fig.1**). Sensitivity, specificity and accuracy rates for ^{99m}TC-MDP in detecting intrarenal focal lesions were calculated to be 100%, 71% and 78% for left kidney and 100%, 68% and 74% for right kidney, respectively as shown in **Table 1 and Table 2**.

Table 1: Comparison between 46 functional images of left renal cortex by using both ^{99m}TC-MDP and ^{99m}TC-DMSA (23 images for each tracer), Sensitivity=100%, specificity=71% and accuracy= 78%.

	MDP Images	**Normal**	**Abnormal**	**Total**
DMSA	**Normal**	**12**	**5**	**17**
Images	**Abnormal**	**0**	**6**	**6**
Total	**12**	**11**	**23**	

The observers showed that the kidneys with clear intrarenal focal lesions by ^{99m}TC-DMSA scintigraphy have the same defect on ^{99m}TC-MDP scintigraphy, as shown in (**Fig. 2**) and (**Fig. 3).** False positive results were observed in ^{99m}TC-MDP images for 5 patients, whose have normal ^{99m}TC-DMSA results for the left kidney (**Table 1**). The number of cases where a left focal lesion detected by ^{99m}TC-MDP were slightly higher than those detected by ^{99m}TC-DMSA as shown in (**Fig.4**). However, there is statistical difference in the comparison between the two tracers for left intrarenal focal lesion with kappa=0.556.

Table 2: Comparison between 46 functional images of right renal cortex by using both ^{99m}TC-MDP and ^{99m}TC-DMSA (23 images for each tracer), Sensitivity=100%, specificity=68% and accuracy= 74%.

	MDP Images	**Normal**	**Abnormal**	**Total**
DMSA	**Normal**	**13**	**6**	**19**
Images	**Abnormal**	**0**	**4**	**4**
Total	**13**	**10**	**23**	

In six patients, ^{99m}TC-MDP scintigraphy gave false positive results for right intrarenal foal lesion compared with ^{99m}TC-DMSA scintigraphy . Also, The number of cases where a right focal lesion detected by ^{99m}TC-MDP were slightly higher than those detected by ^{99m}TC-DMSA (**Fig.4**). However, there is statistical difference in the comparison between the two tracers for right intrarenal focal lesion with kappa=0.430.

A

B

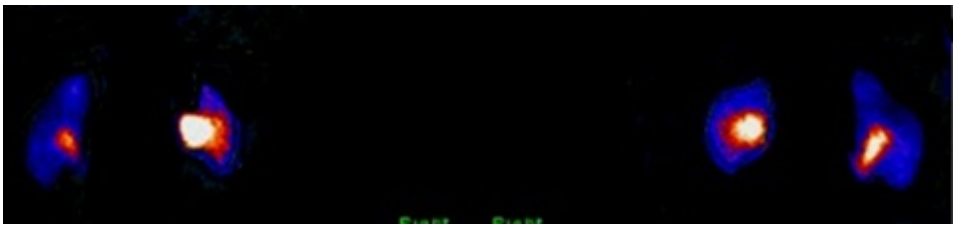
(Fig.1):- Normal kidneys, normal case for female with age 24 years. **A,** image derived from (2–3 hours) static ^{99m}Tc-DMSA scintigraphy. **B,** ^{99m}Tc-MDP scintigraphy.

A

B

(Fig. 2):- Abnormal case with a focal defect and changes of contours for female with age 68 years, **A:** Renal ^{99m}TC-MDP scintigraphy ; **B:** Renal ^{99m}TC-DMSA scintigraphy for the same patient**.**

A



B

(Fig. 3):- A: Normal kidney and normal contours on renal ^{99m}TC-DMSA scintigraphy for male with age 75 years, **B:** Focal defect and change of contours on renal ^{99m}TC-MDP scintigraphy for the same patient.

A

B

(Fig. 4):- A: Renal ^{99m}TC-MDP scintigraphy for male with age 19 years, **B:** Renal ^{99m}TC-DMSA scintigraphy for the same patient.

IV. Discussion

The scan was considered to be abnormal for an old lesion when one or more areas of focal decreased uptake associated with contraction and loss of volume in the involved cortex were noted [9], and Tc-99m dimercaptosuccinic acid (DMSA) scintigraphy has been considered the investigation of choice in the assessment of renal cortical lesions[14] for almost 30 years. Other non-invasive procedures such as intravenous urography (IVU) and ultrasound (US) are considered less sensitive in detection of cortical lesions[15,16], the former at the same time delivering higher radiation dose[17]. The aim of this prospective study was to evaluate the efficacy of bone tracer to visualize intrarenal focal lesions during bone scintigraphy to assess undermine renal disorders.

There were two tracers that used in this study, the first was ^{99m}Tc- dimercaptosuccinicacid (^{99m}Tc-DMSA) is an agent that is actively taken up by the proximal and distal renal tubular cells, directly from the peritubular vessels, not secreted to the tubular lumen[10] and accumulates in the renal cortex[11]. This modality is primarily used for imaging functioning cortical mass and individual renal function[12], and it is the most reliable method for assessing chronic cortical scarring[13].

The second was TC-99m MDP is currently recognized as the most common radiopharmaceutical tool in detecting skeletal metastasis. Techetium-99m-phosphate compounds used in bone scanning are excreted by the kidney, and excellent renal images can be obtained on routine bone scintigraphy. In another study that show the role of ^{99m}TC-MDP in detecting undermine renal disorders, the preoperative bone scans of 49 patients who underwent radical nephrectomy for renal cell carcinoma between 1981 and 1985 were reviewed for renal imaging. Ninety-four percent of the patients had abnormal bone scan renal images (82% had focal decreased uptake, and 12% had focal increased uptake) [7]. Six percent of the renal images were symmetrical bilaterally. When bone scans are employed in the postoperative follow-up of patients with renal cancer, they can be used to assess the status of the remaining kidney[7].

The detection rate of diagnostic values of renal imaging obtained incidentally during bone scintigraphy with TC-99m phosphate compounds ranged from 97.4% [18] for various renal abnormalities to 50% renal space-

occupying lesions [19], and many authors[20-24] reported information about a number of renal abnormalities can be obtained from bone scintigraphy because ^{99m}TC-MDP is excreted through the kidneys to provide adequate visualization of the urinary tract. These abnormalities have included absent renal activity, small or displaced kidneys, urinary obstruction, focal renal parenchymal abnormalities, unilateral decrease in renal function, and asymmetric uptake. Thus, accompany with sufficient excretory amount of MDP, it provides excellent images on kidney at the time of bone scanning, and by high resolution gamma cameras, We can visualize excellent renal image and dynamic derangement of urinary excretion at the time of bone scanning[25]. However, Park[25] and Vieras[26] showed that the detection rate for renal abnormality was 97.4%. Also, Wen-sheng[27] state that ^{99m}Tc-MDP used in detecting renal abnormalities may improve the selection of patients for excretory urolography, and prevent those with high risk of renal abnormalities from going to irreversible stage. So ^{99m}TC-MDP and ^{99m}TC-DMSA examinations should be performed on different days for comparison between their accuracy in detecting intrarenal focal lesions. This study is useful for patients that received radiation therapy and have bone (^{99m}TC-MDP) scintigraphy for early renal damage diagnostic to prevent kidneys from high risk stage.

V. Conclusion

The result confirmed that ^{99m}TC-MDP scintigraphy can simultaneously assess intrarenal focal lesions and skeletal lesions for some patients, but its performance in detecting intrarenal focal lesion is lower than that of ^{99m}TC-DMSA (renal cortical agent). Therefore, in this study for some cases ^{99m}TC-MDP is not a favorite replacement of ^{99m}TC-DMSA for focal lesions diagnosis.

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