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Comparison of Relative Renal Function Measured with Either ^{99m}Tc-DTPA or ^{99m}Tc-EC Dynamic Scintigraphies with that Measured with ^{99m}Tc-DMSA Static Scintigraphy

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ABSTRACT

Objective: The aim of this study was to compare the renal function measured with either ^{99m}Tc-DTPA or ^{99m}Tc-EC dynamic scintigraphies with that measured using ^{99m}Tc-DMSA static scintigraphy.
Methods: the values of relative renal function measured in 111 renal dynamic scintigraphies performed either with ^{99m}Tc-DTPA (55 studies) or with ^{99m}Tc-EC (56 studies) were compared with the relative function measured using ^{99m}Tc-DMSA static scintigraphy performed within a 1-month period. The comparisons were performed using Wilcoxon signed rank test. The number of ^{99m}Tc-DTPA and ^{99m}Tc-EC studies that presented relative renal function different by more than 5% from that measured with ^{99m}Tc-DMSA, using chi square test were also compared.
Results: the relative renal function measured with ^{99m}Tc-EC is not statistically different from that measured with ^{99m}Tc-DMSA ($p = 0.97$). The relative renal function measured with ^{99m}Tc-DTPA was statistically different from that measured using ^{99m}Tc-DMSA, but with a borderline statistical significance ($p = 0.05$). The number of studies with relative renal function different by more than 5% from that measured with ^{99m}Tc-DMSA is higher for the ^{99m}Tc-DTPA scintigraphy ($p = 0.04$) than for ^{99m}Tc-EC.
Conclusion: the relative renal function measured with ^{99m}Tc-EC dynamic scintigraphy is comparable with that measured with ^{99m}Tc-DMSA static scintigraphy, while the relative renal function measured with ^{99m}Tc-DTPA dynamic scintigraphy presents a significant statistical difference from that measured with ^{99m}Tc-DMSA static scintigraphy.

***Key words**: kidney function tests; scintigraphy; DTPA, DMSA*
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INTRODUCTION

Renal scintigraphies have been used for a long time to measure the relative renal function. These methods can be performed with different radiopharmaceuticals as technetium-99m dimercaptosuccinic acid (^{99m}Tc-DMSA), technetium-99m diethylenetriamine pentaacetic acid (^{99m}Tc-DTPA), technetium-99m mercaptoacetyltriglycine (^{99m}Tc-MAG_3), iodine 131 orthoiodohippurate (OIH) and more recently technetium-99m ethylenedicysteine (^{99m}Tc-EC) (1). Although all these methods are accurate to measure this parameter, some differences can be observed among them (2). These differences are caused by distinct biological properties of radiopharmaceuticals such as mechanisms of renal

excretion, renal cells retention of radioactive material, level of plasma-protein bound and level of plasmatic clearance. However, ^{99m}Tc-DMSA as a static renal agent is considered the most reliable method to measure relative renal function (3-5) and the most appropriate tracer for renal cortical imaging (6).

Recently, a new radiopharmaceutical (^{99m}Tc-EC) has been developed to perform renal dynamic scintigraphy and to measure renal relative function. It has similar renal excretion characteristics to ^{99m}Tc-MAG_3 and OIH (7). This radiopharmaceutical has been available for clinical use in Brazil since 2004 and has been used as a substitute for ^{99m}Tc-DTPA to perform the studies. In our subjective experience, ^{99m}Tc-EC appears to be superior to ^{99m}Tc-DTPA to perform the exams. However, there is few data about the comparison of these two methods on medical literature. Therefore, the aim of this study was to analyze the dynamic renal scintigraphies performed either with ^{99m}Tc-EC or with ^{99m}Tc-DTPA to assess if the relative renal functions measured by both methods are similar when compared to that measured using ^{99m}Tc-DMSA.

MATERIALS AND METHODS

We analyzed 111 patients, 52 males, age ranging from 0.17 to 79.00 years (Table-1). A hundred and eleven renal dynamic scintigraphies performed either with ^{99m}Tc-DTPA (55 studies) or with ^{99m}Tc-EC (56 studies) were compared to the relative function measured using ^{99m}Tc-DMSA static scintigraphy performed within a 1-month period (Table-1).

^{99m}Tc-DTPA and ^{99m}Tc-EC dynamic images were acquired with the patients in a supine position and with gamma camera's detector placed in a posterior view. The camera was equipped with an all-purpose, low energy, parallel-hole collimator. Adult patients were injected with 370 to 555 MBq of ^{99m}Tc-DTPA or ^{99m}Tc-EC, and dynamic images were recorded every second for 1 minute and every 15 seconds for 30 minutes. Relative renal function was measured in a composite image (1 to 3 minutes after the injection). Renal and background regions of interest (ROIs) were drawn manually by a skilled nuclear medicine technologist (Figure-1).

^{99m}Tc-DMSA static images were also acquired with the patients in a supine position and with gamma camera's detector placed in a posterior view. The camera was also equipped with an all-purpose, low energy, parallel-hole collimator. Adult patients were injected with 222 MBq of the radiopharmaceutical and static images were acquired 6 hours after in the posterior, left posterior oblique and right posterior oblique projections. Relative renal function was measured in the posterior image. Renal regions of interest (ROIs) were drawn manually by a skilled nuclear medicine technologist and the background regions of interest (ROIs) were drawn automatically by the processing program (Figure-2).

For pediatric patients injected activities were adjusted using the "Pediatric Dose Chart for Radiopharmaceuticals" presented on "The Mayo Clinic Manual of Nuclear Medicine" (8).

Procedures used to acquire and process the images were based on the experience of our nuclear medicine service, on the published experience of others nuclear medicine services (9) and on the Procedure Guidelines of the European Association of Nuclear Medicine and of the Society of Nuclear Medicine (www.eanm.org and www.interactive.snm.org).

Comparison of relative renal function measurement using either ^{99m}Tc-DTPA or ^{99m}Tc-EC dynamic scintigraphies with the one measured using ^{99m}Tc-DMSA static scintigraphy was performed using non-parametric test for related samples (Wilcoxon signed rank test). The number of ^{99m}Tc-DTPA and ^{99m}Tc-EC studies that presented relative renal function different by more than 5% from the relative function measured with ^{99m}Tc-DMSA, using chi square statistical test was also compared. To rule out confounding, the two groups of patients who underwent dynamic scintigraphy (^{99m}Tc-DTPA and ^{99m}Tc-EC) were also compared to assess if there were differences in others parameters. Parameters analyzed were sex, age, and relative renal function (between them, as well as between the correspondent ^{99m}Tc-DMSA studies). Comparisons between groups were performed using a non-parametric test for independent samples (Mann-Whitney) when variables were continuous and chi square test when variables were categorical (sex).

Table 1 – *Patients and results of ^{99m}Tc-EC, ^{99m}Tc-DTPA and ^{99m}Tc-DMSA scintigraphies.*

			DTPA		DMSA					EC		DMSA	
PTES.	**SEX**	**AGE**	**LK (%)**	**RK (%)**	**LK (%)**	**RK (%)**	**PTES.**	**SEX**	**AGE**	**LK (%)**	**RK (%)**	**LK (%)**	**RK (%)**
1	M	15.00	31	69	38	62	56	F	7.25	57	43	57	43
2	M	65.00	48	52	48	52	57	M	45.00	23	77	21	79
3	M	0.33	49	51	46	54	58	F	14.17	69	31	69	31
4	F	53.00	27	73	27	73	59	F	0.75	52	48	53	47
5	F	59.00	54	46	57	43	60	F	1.92	4	96	3	97
6	M	0.50	51	49	51	49	61	M	0.17	53	47	50	50
7	F	3.25	48	52	43	57	62	F	28.00	48	52	52	48
8	M	5.00	53	47	52	48	63	F	4.67	47	53	48	52
9	M	19.00	63	37	63	37	64	M	26.00	51	49	50	50
10	F	61.00	88	12	98	2	65	F	56.00	8	92	1	99
11	F	72.00	54	46	55	45	66	F	48.00	49	51	49	51
12	M	45.00	32	68	23	77	67	M	5.50	62	38	62	38
13	M	0.17	64	36	66	34	68	M	8.50	49	51	48	52
14	F	58.00	48	52	48	52	69	F	3.00	53	47	52	48
15	F	55.00	59	41	60	40	70	M	7.92	49	51	50	50
16	F	1.50	48	52	52	48	71	M	23.00	34	66	35	65
17	F	70.00	38	62	24	76	72	F	31.00	47	53	48	52
18	F	9.92	57	43	60	40	73	M	1.42	48	52	53	47
19	M	25.00	24	76	25	75	74	F	54.00	27	73	28	72
20	M	6.67	46	54	47	53	75	F	47.00	51	49	52	48
21	M	79.00	89	11	99	1	76	F	29.00	52	48	53	47
22	M	69.00	21	79	9	91	77	F	43.00	52	48	50	50
23	M	0.75	54	46	55	45	78	F	30.00	55	45	54	46
24	F	0.42	52	48	51	49	79	M	9.33	51	49	51	49
25	M	12.00	4	96	2	98	80	F	10.00	48	52	50	50
26	F	44.00	20	80	23	77	81	F	31.00	56	44	57	43
27	F	43.00	48	52	48	52	82	M	11.00	53	47	52	48
28	F	13.58	52	48	48	52	83	F	68.00	55	45	51	49
29	F	10.58	32	68	31	69	84	F	23.00	50	50	51	49
30	F	26.00	37	63	38	62	85	M	0.33	45	55	50	50
31	F	12.58	49	51	51	49	86	M	3.83	47	53	49	51
32	M	27.00	50	50	53	47	87	M	30.00	45	55	48	52
33	F	32.00	54	46	53	47	88	M	12.00	50	50	51	49
34	F	13.08	49	51	53	47	89	M	29.00	52	48	53	47
35	F	53.00	50	50	50	50	90	M	1.00	58	42	54	46
36	M	16.67	42	58	51	49	91	M	44.00	14	86	14	86
37	M	12.08	49	51	50	50	92	F	27.00	47	53	48	52
38	M	19.50	23	77	19	81	93	F	56.00	69	31	69	31
39	M	0.58	41	59	43	57	94	F	12.00	50	50	52	48
40	M	22.00	53	47	48	52	95	F	12.00	60	40	59	41
41	F	31.00	29	71	31	69	96	F	12.00	50	50	48	52
42	M	59.00	53	47	51	49	97	F	23.00	89	11	89	11
43	M	39.00	16	84	3	97	98	F	78.00	52	48	58	42
44	F	1.25	53	47	49	51	99	F	55.00	21	79	22	78
45	M	47.00	60	40	68	32	100	F	39.00	55	45	51	49
46	F	23.00	42	58	40	60	101	F	40.00	54	46	54	46
47	M	42.00	51	49	51	49	102	F	44.00	46	54	42	58
48	F	11.25	48	52	51	49	103	M	18.00	46	54	48	52
49	M	35.00	54	46	53	47	104	F	3.67	60	40	61	39
50	M	11.17	52	48	47	53	105	M	0.75	50	50	52	48
51	M	7.08	40	60	40	60	106	M	73.00	43	57	42	58
52	M	55.00	47	53	48	52	107	F	39.00	54	46	55	45
53	M	0.83	48	52	53	47	108	M	1.25	56	44	62	38
54	F	36.00	83	17	91	9	109	M	5.00	46	54	45	55
55	F	0.42	41	59	46	54	110	M	29.00	80	20	81	19
							111	F	19.00	50	50	49	51

DTPA = diethylenetriamine pentaacetic acid; DMSA = dimercaptosuccinic acid; EC = ethylenedicysteine; Ptes = patients; LK = left kidney; RK = right kidney.

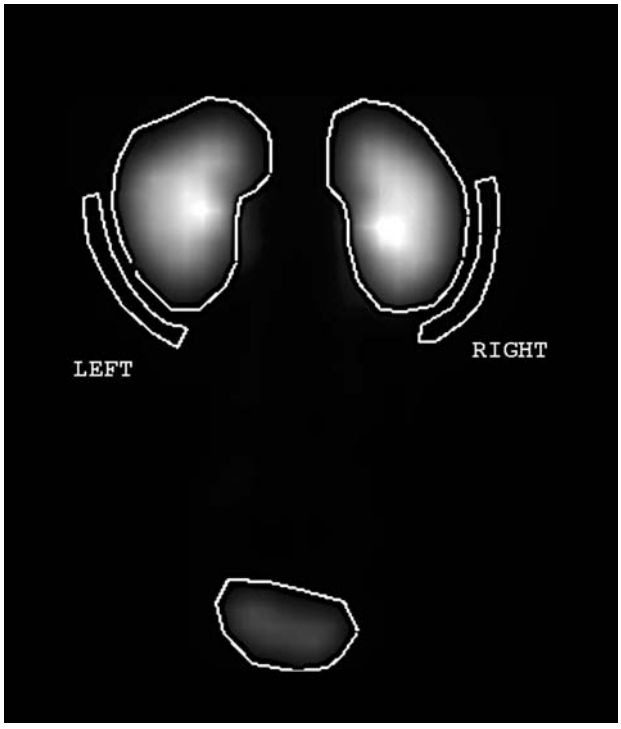

***Figure 1** – Regions of interest (ROIs) drew manually in a composite image (1 to 3 minutes after the injection) of the ^{99m}Tc-DTPA or ^{99m}Tc-EC dynamic scintigraphies.*

***Figure 2** – Renal regions of interest (ROIs) drew manually in the posterior image of 99mTc-DMSA scintigraphy and background regions of interest (ROIs) drew automatically by the processing program.*

RESULTS

Relative renal function measured with ^{99m}Tc-EC was not statistically different from that measured with ^{99m}Tc-DMSA ($p = 0.97$). Relative renal function measured with ^{99m}Tc-DTPA was distinct from that measured with ^{99m}Tc-DMSA, but with a marginal statistical significance ($p = 0.05$). The number of studies with relative renal function different by more than 5% from the one measured with ^{99m}Tc-DMSA is higher for the ^{99m}Tc-DTPA scintigraphy (10 in 55) than for ^{99m}Tc-EC (3 in 56) ($p = 0.04$). There was no significant statistical difference in the control parameters between the two groups (^{99m}Tc-DTPA and ^{99m}Tc-EC): sex ($p = 0.22$), age ($p = 0.58$), left and right kidney functions in dynamic scintigraphies ($p = 0.22$), and left and right kidney functions in static scintigraphies ($p = 0.15$).

DISCUSSION

As already mentioned on the introduction, there are few papers comparing ^{99m}Tc-DTPA with ^{99m}Tc-EC. In a MEDLINE search (October 06, 2005) using key words (DTPA AND EC AND Scintigraphy AND Renal) only one paper comparing the two methods was retrieved (10). This paper compares the diagnostic accuracy of ^{99m}Tc-EC with ^{99m}Tc-DTPA in the assessment of renal artery stenosis. It concludes that although there is no significant difference between ^{99m}Tc-EC and ^{99m}Tc-DTPA captopril scintigraphy for detecting renal artery stenosis, the better imaging characteristics and more confident interpretation provided by ^{99m}Tc-EC make it a preferential radiopharmaceutical to perform the scintigraphy. There are also studies (11,12) comparing relative renal function measured with ^{99m}Tc-EC and ^{99m}Tc-DMSA showing a high correlation between these two methods.

In our group of patients, relative renal function measured with ^{99m}Tc-EC appears to be more accurate than the one measured with ^{99m}Tc-DTPA, if the ^{99m}Tc-DMSA static scintigraphy is considered the "gold standard" method. One reason for this difference may be the different mechanisms of renal excretion for these radiopharmaceuticals (^{99m}Tc-DTPA is excreted by glomerular filtration whereas ^{99m}Tc-EC and ^{99m}Tc-DMSA are excreted primarily by proximal convoluted tubules). Although these two mechanisms of excretion are highly correlated, they are not identical and some patients could have a more pronounced

impairment in one of them (13,14). Another possible reason for this difference is the higher level of background activity (extra-renal activity) presented in dynamic renal scintigraphy with ^{99m}Tc-DTPA due to its low extraction efficiency (20%) when compared to the tubular secreted radiopharmaceuticals (15).

CONCLUSION

Relative renal function measured with ^{99m}Tc-EC dynamic scintigraphy is comparable to that measured with ^{99m}Tc-DMSA static scintigraphy, while relative renal function measured with ^{99m}Tc-DTPA dynamic scintigraphy presents a statistical significant difference from that measured with ^{99m}Tc-DMSA static scintigraphy.

CONFLICT OF INTEREST

None declared.

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