Renal scan images with ^{99m}Tc-TPAC and ^{203}Hg-Chlormerodrin according to kidney function

Yoshihiko Oshiumi, M.D.*, Hiroshi Hirata, M.D. **, Hiromu Nishitani, M.D.***, Issei Koga, M.D.*** and Takashi Nakayama, M.D.***

Present address: *Chief, Department of Radiology, Hiroshima Red Cross and Atomic Bomb Hospitals

**Chief, Department of Urology, Hiroshima Red Cross Hospital

***Department of Radiology, Faculty of Medicine, Kyushu University, Fukuoka

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腎機能からみた ^{99m}Tc-TPAC 及び ^{203}Hg-Chlormerodrin による renal scaning image の比較検討

広島赤十字病院・広島原爆病院 放射線科

鴛海 良彦

広島赤十字病院 泌尿器科

平田 弘

九州大学医学部放射線科学教室

西谷 弘 古賀 一誠 中山 卓

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^{99m}Tc-penicillamin acetazolamide complex (TPAC) は Halpern, S らによつて開発された renal scanning agent である.

著者らは，腎障害のある24例について，腎機能の点から ^{99m}Tc-TPAC と ^{203}Hg-Chlormerodrin の renal imageを比較検討した. 腎機能検査として，PSP，GFR，BUN，血清 creatinin, 濃縮テスト，indigo carmin 色素排泄試験，IVP, DIP, renogram, renal angiography を行なつた. 但し，DIPと renal angiography は必要に応じて行なつたものである.

^{99m}Tc-TPAC 1～2 mCi 静注後，5分，15分，30分，60分に nuclear chicago 製 Pho/Gamma III scinticameraで撮像した. 続いて島津製 SCC 130 W Scannerで scan した. ^{203}Hg-Chlormerodrin による scan は，^{99m}Tc-TPAC による scan から3日以内に行なつた. scan image の比較は scanner による photoscintigram で行なつた.

各腎の腎機能は，腎障害の度合に応じて0度，I度，II度の3群に分けた.

^{99m}Tc-TPAC による image が ^{203}Hg-Chlormerodrin によるものに比べて優れていたのは，腎障害I度で52%，II度で75%であつた.

この結果，高度障害腎に対して ^{99m}Tc-TPAC では ^{203}Hg-Chlormerodrin よりも優れた image が得られることがわかつた.

腎障害が高度で，他の検査法にても腎の形態について information が得られないときでも ^{99m}Tc-TPAC による scan は有用である．

腎被曝線量が極めて低いという事もあり，将来 ^{99m}Tc-TPAC は ^{203}Hg-Chlormerodrin に代つて広く使用されるべき renal agent であると考える．

Abstract

In twenty-four cases with renal disorders the scan images of ^{99m}Tc-TPAC and ^{203}Hg-Chlormerodrin were compared according to renal function. Fifty-two percent of those with Grade I and seventy-five percent with Grade II dysfunction had superior renal images with ^{99m}Tc-TPAC as compared to ^{203}Hg-Chlormerodrin. This scanning was especially useful when other methods of examination failed to provide adequate information about the morphology of the kidneys during severe renal disorders.

^{203}Hg-Chlormerodrin is widely used in renal scanning. Since it accumulates primarily in the kidneys and its extra-renal excretion is slow, it is regarded an outstanding scanning agent. However, with a rather high dose of 5–10 rad/150 μCi to the kidneys (3), it poses a problem from the standpoint of minimizing patients' exposure doses.

Labeled compounds with short half-lives, such as ^{113m}In and ^{99m}Tc used in scanning other organs, incur very small doses.

Agents, to be appropriate for renal scanning, must meet the following criteria:

1. Accumulation of the agent must be specific for and of large concentration in the kidneys.
2. Extra-renal excretion must be slow.
3. Dose must be small.

In addition, they should produce high quality images of the kidneys, even during severe renal disorders.

^{99m}Tc-penicillamine acetazolamide complex (TPAC) reported in 1972 by Halpern et al. (4) is a superior agent in fulfilling there requirements. Even during very severe renal disorders it reportedly produces outstanding scan images.

In the present study, we compared scan images obtained using ^{99m}Tc-TPAC* with those using ^{203}Hg-Chlormerodrin in patients with renal disorders.

^{99m}Tc-TPAC is very stable. Of that administered intravenously, ninety-seven percent is bound

Table 1: Preparatory Procedures for ----Tc-TPAC (4)

1. To a sterile, pyrogen-free, 15-ml centrifuge tube add 4.0 ml $^{99m}TcO_4^-$, and the following:
2. 60 mg D penicillamine
3. 1.0 ml concentrated HCl (11.6 N)
4. 40.0 mg acetazolamide
5. Adjust the pH to 8.5 with NaOH. Shake gently until the powdered chemicals go into solution
6. Autoclave 15 min at 15 lb pressure
7. Cool under running water and filter through a 0.22 micron Millipore filter

*Courtesy of Dainabot Radioisotope Laboratory.

to serum protein, particularly to its albumin fraction. No more than four-eight percent is extracted on a single passage through the kidney, the extraction becoming less with increasing time (4).

Preparation is simple, as shown in Table I. If a milipore filter is unavailable, the supernatant fluid can be administered intravenously. No side effects are observed. Scanning is best seen 60–70 minutes after injection.

Materials and Methods

Twenty-four subjects with renal disorders were selected from patients of the Urology Department of Hiroshima Red Cross Hospital-Hiroshima A-bomb Hospital June through September 1972.

They received the following renal function tests:

I. Total renal function tests

1. PSP
2. Glomerular filtration rate (GFR)
3. Blood urea nitrogen (BUN)
4. Serum creatinine
5. Fishberg test

II. Split renal function tests

1. Indigo carmine test
2. Intravenous pyelography (IVP)
3. Radioisotope renogram
4. Drip-infusion pyelography (DIP)
5. Renal angiography

The latter two were performed when clinically indicated.

One to two mCi of ^{99m}Tc-TPAC and 150–300 μCi ^{203}Hg-Chlormerodrin were administered intravenously. Pho/Gamma III scinticamera* observations were at 5, 15, 30 and 60 minutes post-injection, and scanning with a Shimadzu SCC 130 W scanner**, at 60 minutes.

Within 3 days of ^{99m}Tc-TPAC scanning, the procedure was repeated with ^{203}Hg-Chlormerodrin. Photo-scintigraphy by rectilinear scanning was used to compare the scan images.

According to the severity of renal functional disorders, the kidneys were classified as Grades O, I and II, with normal kidneys represented by O; slight to moderate functional disorders, Graded as I; and severe functional disorders, as II. For classification as Grade II: (1) the PSP test showed a 15 minute excretion of less than seven percent, and a total 120 minute excretion of less than thirty percent; (2) the BUN was greater than 40 mg/dl; (3) the serum creatinine exceeded 4.0 mg/dl; (4) the GFR was less than 40 ml/min; (5) the Fishberg test result was less than 1010; (6) there was no visualization on intravenous pyelography 15 minutes post injection; (7) the radioisotope renogram indicated a hypofunctional (H) or nonfunctional (N) type. The kidneys not meeting the foregoing criteria were graded as I. The Patterns of the radioisotope renograms were classified by type as: standard (S); delayed (D); obstructive (O); hypofunctional (H) and nonfunctional types (N) (6).

*Manufactured by Nuclear Chicago.

**Manufactured by Shimadzu.

Table II: Laboratory Findings of Selected Cases

Case	Age	Sex	Diseases	PSP (%) 15 min.	PSP (%) Total	BUN mg/dl	Cr mg/dl	GFR ml/min	Fish-berg Test	Indigo-carmin Test	IVP* 15 min.	Radio-isotope Renogram
1	64	male	Bilateral nephrolithiasis, hydronephrosis	8	52	20.2	1.18	74	1020	R L 7′(±)	2 2	O O
2	44	male	Right renal tuberculosis	24	65	18.6	1.08	86	1024	R 10′(−) L	O 2	N S
3	58	male	Polycystic kidney, left nephrectomy	1	10	54.5	4.5	19	1009	R L	O	H
4	35	male	Right ureteral calculus; right hydronephrosis	23	76	11.0	0.95	89	1017	R 10′(±) L	1 2	H S
5	50	female	Postoperative right ureteral calculus; left nephrolithiasis	6	47	17.0	1.05	56	1018	R 10′(−) L 7′(±)	1 1	N D
6	45	female	Polycystic kidney	15	62	12.4	0.63	69	1020	R L 7′(−)	1 1	D D
7	70	male	Vesical tumor	21	63	22.6	1.47	68	1015	R (−) L 5′(+)	0 1	N D
8	35	male	Polycystic kidney	19	77	16.7	1.25	76	1020	R L	2 1	S D
9	25	female	Polycystic kidney	18	62	14.0	1.2	74	1020	R 6′(±) L	1 1	H D
10	27	female	Renal hypertension; contracted kidney, left	12	57	13.0	1.2	80	1028	R L 10′(±)	2 0	S N
11	50	female	Sponge kidney, left; pyelonephritis	28	75	10.2	1.5	80	1009	R L 7′(±)	2 1	S D
12	55	female	Polycystic kidney; left left nephrectomy	0	6	61.0	6.2	11	1008	R 10′(−) L	0	N

13	43	female	Renal insufficiency	1	5	54.0	4.1	19.6	1008	R 10′(−) L 10′(−)			N		N
14	46	Chronic pyelonephritis		20	72	13.4	1.1	56.2	1016	R L	1	1	D		D
15	80	female	Bilateral nephrolithiasis	5	32	23.6	2.2	52	1010	R 10′(−) L 7′(−)	0	1	N		D
16	49	male	Right ureteral stricture; hydronephrosis	20	65	21.4	1.9	80	1027	R 7′(−) L	1	2	O		D
17	23	female	Neurogenic urinary bladder; chronic pyelonephritis	5	62	17.0	0.8	68	1020	R L 10′(−)	1	2	H		D
18	47	male	Chronic pyelonephritis	25	75	8.8	0.8	116	1018	R 3′(−) L 3′(−)	2	2	D		D
19	65	male	Cystectomy; bilateral uretero-cutaneostomy	R 6 L 3	R 40 L 16	14.3	2.1	R 40 L 26	R 1017 L 1010	R L	1	0	D		H
20	43	male	Normal kidney	44	89	9.0	0.9	126	1022	R L	2	2	S		S
21	60	male	Normal kidney	22	75	6.0	0.8	118	1020	R L	2	2	S		S
22	41	female	Polycystic kidney	15	52	13.2	1.2	69	1018	R L 6′(±)	1	1	D		D
23	48	female	Bilateral hydronephrosis	6	44	12.8	1.0	58	1014	R 7′(±) L 10′(−)	1	0	D		O
24	59	male	Left renal cyst; non-functioning right kidney	23	74	11.9	1.0	112	1020	R (−) L 5′(+)	0	2	N		S

*Degree of visualization : 0 = non
1 = poor
2 = good

Table III: Relative value of scintigrams using ^{99m}Tc- and ^{203}Hg-, by renal dysfunction.

Case	Side	Grade	Scintigram ^{203}Hg	Scintigram ^{99m}Tc	Comparison (^{99m}Tc Equal or Superior to ^{203}Hg)
1	R	I	1	2	superior
	L	I	1	2	superior
2	R	II	0	2	superior
	L	0	2	2	superior
3	R	II	0	2	superior
	L				
4	R	I		2	
	L	0		2	
5	R	II	0	2	superior
	L	I	2	2	superior
6	R	I	1	2	superior
	L	I	1	2	superior
7	R	II	0	0	superior
	L	I	1	2	superior
8	R	0	2	2	equal
	L	I	2	2	equal
9	R	I	0	2	superior
	L	I	2	2	superior
10	R	0	2	2	equal
	L	II	1	2	superior
11	R	0	2	2	equal
	L	I	2	2	equal
12	R	II	0	2	superior
	L				
13	R	II	0	2	superior
	L	II	0	2	superior
14	R	I	2	2	equal
	L	I	2	2	equal
15	R	II	0	0	equal
	L	I	2	2	equal
16	R	I	1	2	superior
	L	I	2	2	equal
17	R	I	2	2	equal
	L	I	2	2	equal
18	R	I	2	2	equal
	L	I	2	2	equal
19	R	I	2	2	superior
	L	II	1	2	superior
20	R	0		2	
	L	0		2	
21	R	0		2	
	L	0		2	
22	R	I	2	2	superior
	L	I	2	2	superior
23	R	I	2	2	equal
	L	II	2	2	equal
24	R	II	0	0	
	L	0	1	2	superior

Results

Results of the renal function tests are shown in Table II. Among the 24 subjects, CASES XX and XXI, were normal; the other 22 had renal disorders, two of whom each had one kidney. CASE XIX had a bilateral ureterocutaneostomy.

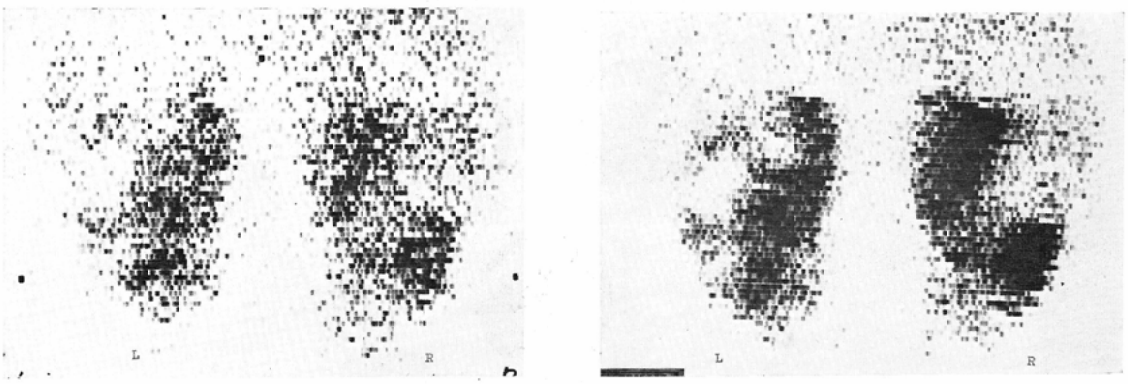
The severity of functional disorders and the corresponding scan images obtained are summarized in Table III. The scan images obtained with ^{203}Hg-Chlormerodrin and ^{99m}Tc-TPAC were rated O a renal image was not obtained; 2, when the renal images were distinctly visualized; and 1, for indistinct images. The differences between the scan images obtained with ^{203}Hg-Chlormerodrin and those with ^{99m}Tc-TPAC are indicated in each kidney.

a. Scan Images of Space-Occupying Lesions

CASE VI: This 45-year-old female with polycystic kidneys had a PSP of fifteen percent in 15 minutes and a total of sixty-two percent; a BUN of 12.4 mg/dl; a 0.63 mg/dl serum creatinine; a GFR of 69 ml/min; a 1020 Fishberg test; and an indigo carmine test demonstrating no excretion from either kidney after 7 minutes. The IVP renal visualization was poor at 15 minutes, and a radioisotope renogram indicated both to be type D. The kidneys were Grade I. The corresponding scintigrams are shown in Figure 1. The scan image using ^{203}Hg-Chlormerodrin could not establish the numbers and sizes of the cysts, though those produced by ^{99m}Tc-TPAC defined the cysts well.

b. Scan Images of the Contracted kidney

CASE V. Had a history of a right ureterolithotomy. He currently had a staghorn calculus of the left kidney. A contracted right kidney was demonstrated by drip infusion pyelography. The renal function tests were as follows: PSP was six percent in 15 minutes with a total of forty-seven percent. She had a BUN of 17.0 mg/dl, a 1.05 mg/dl serum creatinine, a GFR of 56 ml/min. A Fishberg test was 1018, and an indigo carmine test showed the right kidney to have no excretion in 10 minutes; the left kidney, a slight increase in excretion at 7 minutes. On intravenous pyelography both kidneys were poorly visualized at 15 minutes. A radioisotope renogram showed the right kidney to be type N; the left, type D (Fig. 2, A). Accordingly, the right kidney was classified as Grade II; the left, Grade I.



^{203}Hg ^{99m}Tc

Fig. 1, A, B: Scintigrams of CASE VI, with cysts poorly visualized by ^{203}Hg-Chlormerodrin, but well visualized with ^{99m}Tc-TPAC.

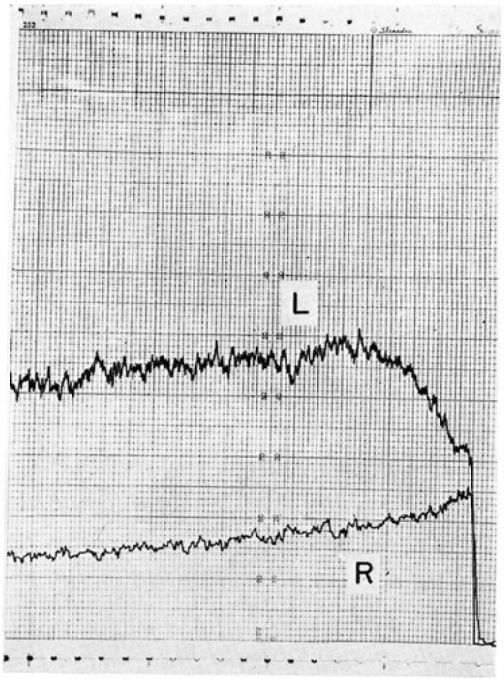


Fig. 2, A: Renogram of CASE V. The right kidney is type N, the left, type D.

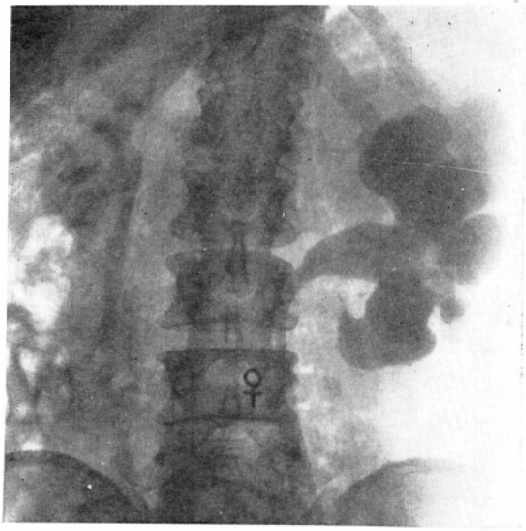


Fig. 2, B: Drip infusion pyelogram, showing staghorn calculus in left kidney and contracted right kidney.

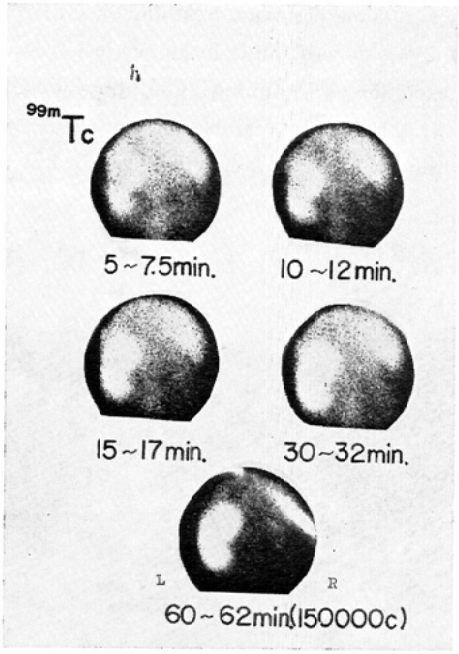
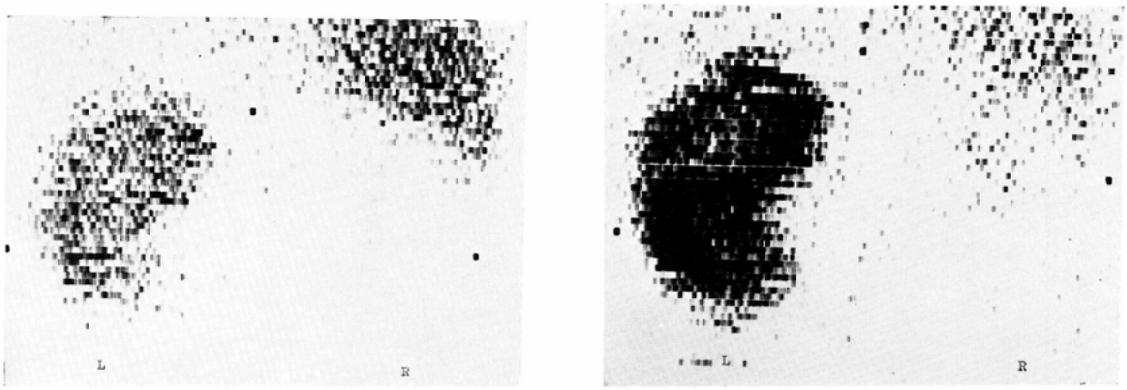


Fig. 2, C: Serial images by scinticamera, showing elevated radioactivity in the right kidney, 60–62 min postinjection.



^{203}Hg ^{99m}Tc

Fig. 2, D, E: Scintigrams of the same case, using a ^{203}Hg-scan, showing no radioactivity in the right kidney, but radioactivity, using ^{99m}Tc-scan.

Drip infusion pyelography showed the left kidney to be enlarged and it contained a staghorn calculus. The right kidney was contracted, and its small renal pelvis was only faintly visualized (Fig. 2, B). The image obtained by ^{99m}Tc-TPAC was periodically observed by scinticamera, and the radioactivity gradually increased, even in the severely disordered right kidney. Radioactivity reached its maximum level 60 minutes post-injection and the renal image was faintly visualized (Fig. 2, C). Rectilinear scanning with ^{203}Hg-Chlormerodrin showed no radioactivity in the right kidney. However, the image with ^{99m}Tc-TPAC indicated considerable radioactivity in the right kidney, corresponding to the image on drip infusion pyelography (Figs. 2, D, E).

c. Scan Images of the Internal Structure of the Renal Tuberculosis

CASE II: A 44-year-old male with right renal tuberculosis had the following renal function tests: Twentyfour percent PSP excretion in 15 minutes, with a total of sixty-five percent; an 18.6 mg/dl BUN; a 1.08 mg/dl serum creatinine; a 86 ml/min GFR; a 1024 Fishberg test, and an indigo carmine test showing the right kidney to have no excretion in 10 minutes. On intravenous pyelography, the right kidney could not be visualized in 15 minutes; whereas, the left was well-visualized. The right kidney was classified type N; the left, type S, by radioisotope renogram (Fig. 3, A). Accordingly, the right kidney was graded II; the left, I.

The scan images of the severely disordered right kidney were compared (Figs. 3, B, C). Using ^{203}Hg-Chlormerodrin, there was no radioactivity in the right kidney. With ^{99m}Tc-TPAC the lack of uniformity in the right kidney indicated incomplete impairment by tuberculous lesions, with function still remaining in parts of the kidney.

d. Scan Images of the Severely Impaired Polycystic Kidney

CASE XII: This 55-year-old female with polycystic kidneys had had a left nephrectomy. Renal function tests after surgery included a zero percent PSP excretion in 15 minutes, with a total of six percent; 61.0 mg/dl BUN, 6.2 mg/dl serum creatinine; a GFR 11.0 ml/min; a 1008 Fishberg test; and no IVP visualization in 15 minutes. The results of the radioisotope renogram were classified as type N.

Scintigram (Fig. 4, A), by ^{203}Hg-Chlormerodrin showed no radioactivity in the right kidney. A

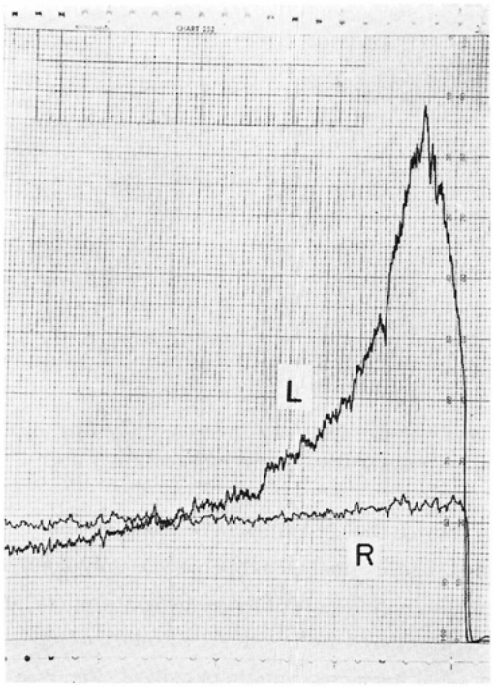
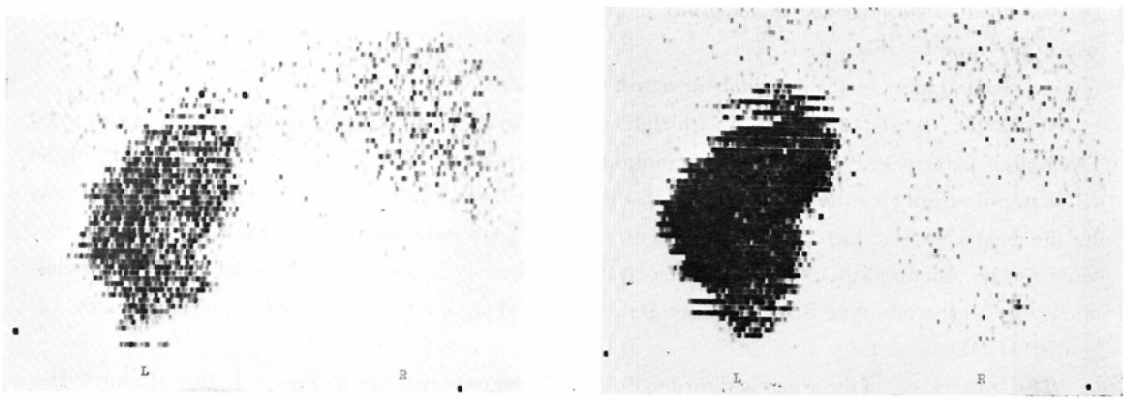


Fig. 3, A: Renogram of CASE II. The right kidney is type N, the left type S.

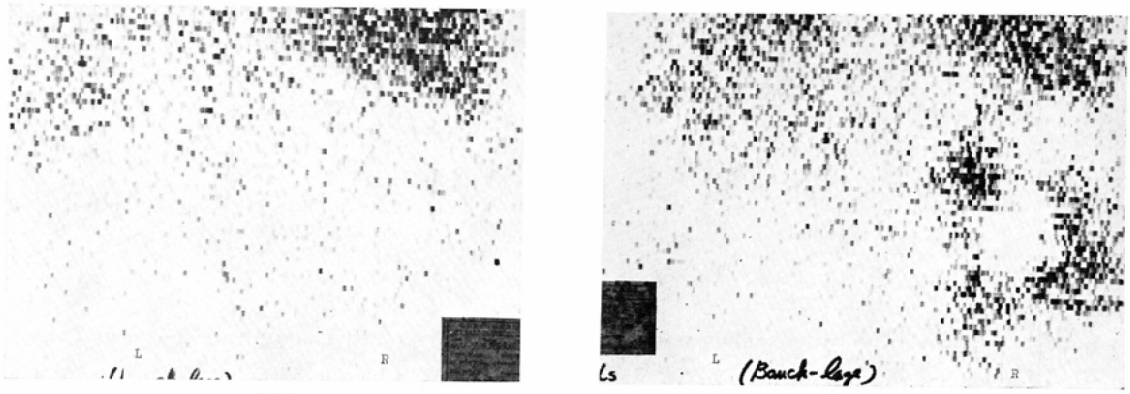


^{203}Hg　　^{99m}Tc

Fig. 3, B, C: Scintigrams of the same case, using ^{203}Hg-scan showing no radioactivity in the right kidney, but with ^{99m}Tc-scan, radioactivity in parts of the kidney with some function still remaining.

scan with ^{99m}Tc-TPAC showed a sharp renal image and space-occupying lesions (Fig. 4, B).

For the 28 kidneys whose visualization on IVP was either poor or unobtainable, the scan images rated 2 by ^{203}Hg-Chlormerodrin and ^{99m}Tc-TPAC were compared, and the results are shown in Table IV. For kidneys with poor visualization on intravenous pyelography, renal images were obtained with ^{203}Hg-Chlormerodrin in 13 of 19 subjects, with poor visualization by intravenous pyelography and in



^{203}Hg ^{99m}Tc

Fig. 4, A, B: Scintigrams of CASE XII, using ^{203}Hg-scan showing no radioactivity in the right kidney, but using ^{99m}Tc-scan, a sharp renal image with a space-occupying lesion.

Table IV: Comparison of visualization with ^{203}Hg- and ^{99m}Tc-scintigrams according to intravenous pyelography.

Visualization: 2 / IVP	^{203}Hg-Chlormerodrin	^{99m}Tc-TPAC
Poor visualization	13/19	19/19
Nonvisualization	1/9	6/9

(Total: 28 kidneys)

Table V: Comparison of visualization with ^{203}Hg- and ^{99m}Tc- scintigrams according to renograms types, H, N kidneys.

Visualization: 2 / Renograms	^{203}Hg-Chlormerodrin	^{99m}Tc-TPAC
Type H	2/4	4/4
Type N	0/9	6/9

(Total: 13 kidneys)

one of 9 subjects with no visualization. Whereas, with ^{99m}Tc-TPAC renal images could be obtained in all with poor visualization, in 6 of 9 subjects with non visualization.

For 13 kidneys with renograms which were classified as type H or N, the scan images using both agents were also compared (Table V). Using ^{203}Hg-Chlormerodrin, in 2 of 4 type H kidneys, renal images were obtained. However, with ^{99m}Tc-TPAC, renal images resulted in all 4 cases. In none of the type N kidneys, did renal images result using ^{203}Hg-Chlormerodrin; whereas, with ^{99m}Tc-TPAC, renal images were obtained in 6 of 9.

These results indicate that renal images are frequently obtainable using ^{99m}Tc-TPAC in cases with impaired renal function. The relative superiority of ^{99m}Tc-TPAC and ^{203}Hg-Chlormerodrin in renal scanning was studied. Image qualities using each of these scanning agents were evaluated as superior,

Table VI: Comparison of visualization by ^{203}Hg- and ^{99m}Tc-scintigrams.

Visualization \ Renal Impairment	Grade I	Grade II
Superior	12 (52%)	9 (75%)
Equal	11 (48%)	3 (25%)
Inferior	0 (0%)	0 (0%)
Total	23 (100%)	12 (100%)

(Total: 35 kidneys)

equal or inferior. The corresponding results for the 35 kidneys graded I and II are shown in Table VI. For kidneys graded I, ^{99m}Tc-TPAC was better than ^{203}Hg-Chlormerodrin in fifty-two percent, but for kidneys graded II, it was equivalent to ^{203}Hg-Chlormerodrin in only twenty-five percent, and better than ^{203}Hg-Chlormerodrin in seventy-five percent (Table VI).

Discussion

With the increasingly frequent use of procedures in nuclear medicine, the patients' exposure doses have become a major problem. Total body and renal exposure doses from scanning procedures as previously reported are summarized in Table VII (3, 10). ^{99m}Tc-TPAC is one of the renal scanning agents incurring relatively small exposure doses. Renal exposure dose from ^{99m}Tc-TPAC is considered of the same magnitude as that of the ^{99m}Tc-ascorbic acid complex.

Table VII: Absorbed doses

	mrad/μCi	
	Total	Kidneys
1. ^{131}I-Hippuran	0.03–0.2	0.1–1
2. ^{197}Hg-Chlormerodrin	0.1	7
3. ^{203}Hg-Chlormerodrin	1–2	60–70
4. ^{203}Hg-Salyrgan	(0.3–1.4 rad/200 μCi)	
5. ^{99m}Tc-iron ascorbic acid complex	0.008	0.27
6. ^{99m}Tc-DTPA	0.016	0.042

Renal diagnostic X-ray procedures have likewise improved. Intravenous, retrograde and drip-infusion pyelography are frequently performed. The introduction of Seldinger's angiographic techniques has permitted selective renal angiography with relative ease. When renal function is severely impaired, however, these procedures are frequently inappropriate. With BUN values exceeding 50 mg/dl, the kidneys usually cannot be visualized on intravenous pyelography, and drip-infusion pyelography is the procedure of choice, though a clear nephrogram is not necessarily obtainable in all cases (7, 8). Selective renal angiography allows more precise diagnoses of renal disease, but has the inherent potential danger of inducing renal insufficiency in patients with severely impaired kidneys (1, 2).

The renal scanning described here is no great physical burden for the patient, has no associated hypersensitivity. Its images are not affected by the presence of intestinal gas, and it can be performed easily. For morphological study of severely impaired kidneys, a renal image of high quality is desirable; however, ^{203}Hg-Chlormerodrin, though currently in wide use, is not appropriate for this.

The more recent ^{99m}Tc-labeled compounds result in relatively good scan images of the im paired kidney.

When the serum creatinine exceeds 3.0 mg%, the scan images using ^{99m}Tc-iron ascorbic acid complex are relatively poor (9). With ^{99m}Tc-DTPA the scan image quality is directly proportional to the glomerular infiltration rate (5). With ^{99m}Tc-TPAC, scintiphotos of high resolution are obtainable, even with creatinine clearances of 3–5 ml/min (4).

Observing 22 patients with renal disorders and 2 normal subjects, we compared the scan images using ^{99m}Tc-TPAC and ^{203}Hg-Chlormerodrin according to renal function. In kidneys visualized poorly or not at all by intravenous pyelography, scan images were more frequently obtained using ^{99m}Tc-TPAC. In kidneys categorized type H and N by radioisotope renograms, scans with ^{99m}Tc-TPAC were superior.

The scan images obtained using these two agents were compared according to our grading of renal dysfunction. Fifty-two percent of those with Grade I and seventy-five percent with Grade II dysfunction had superior renal images with ^{99m}Tc-TPAC as compared to ^{203}Hg-Chlormerodrin. Thus, ^{99m}Tc-TPAC is superior to ^{203}Hg-Chlormerodrin, even for kidneys with severe disorders.

Only some of our representative cases are illustrated here, but in all those of this series, the renal images were sharp and the lesions were well-visualized with ^{99m}Tc-TPAC.

Scanning with ^{99m}Tc-TPAC is especially useful when kidneys with severe disorders cannot be studied by drip-infusion pyelography or selective renal angiography. Renal size, the site and extent of lesions, and the extent of ramaining normal tissue and its function potential can be ascertained. For these reasons we feel that ^{99m}Tc-TPAC will become more widely used in the future, eventually replacing ^{203}Hg-Chlormerodrin.

Summary

^{99m}Tc-TPAC is reportedly a superior agent for renal scanning, not only because of its relatively low kidney exposure dose, but because of the outstanding renal scan images it produces even in severe disorders. The authors compared the scan images of ^{99m}Tc-TPAC and ^{203}Hg-Chlormerodrin according to renal function, and the scan image quality indicated ^{99m}Tc-TPAC superior to ^{203}Hg-Chlormerodrin. Renal scanning with ^{99m}Tc-TPAC is especially useful when other methods of examination fail to provide adequate information about the morphology of kidneys with severe disorders.

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