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CLINICAL EVALUATION OF RADIONUCLIDE STUDY IN DIAGNOSIS OF POLYCYSTIC KIDNEYS

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Our clinical experiences with 70 cases of polycystic kidneys were reviewed and presented with the pertinent radionuclide and other radiological findings. Radionuclide scanning and excretory urography provided satisfactory diagnostic informations in cases with normal renal function. However, in cases with impaired renal function, with serum creatinine over 4 mg per 100 ml or blood urea nitrogen over 50 mg per 100 ml, ultrasonography and computed tomography should be recommended as useful additional diagnostic measures. The investigation of associated polycystic lesions in the other organs revealed polycystic lesion of the liver in 37 of 60 cases (61.6%).

The value of radionuclide study in diagnosis of urological disorders is generally recognized as a harmless and non-time-wasting technique. The diagnostic value of it was estimated and compared with that of the other radiological and pararadiological studies.

MATERIALS

Our study consists of 70 cases of polycystic kidneys seen at the Kitasato University Hospital during the years 1972 to 1978. The youngest patient is 3 years old, while the oldest is 80 years old. The highest incidence is noted in the fourth decade. The sex distribution is almost equal; 37 males and 33 females.

The diagnosis of this lesion is based on clinical history, physical examination, laboratory data, and radiological examinations, including renal radionuclide study, excretory urography, ultrasonography, computed tomography, and angiography. Unilateral nephrectomy was performed in 5 patients and bilateral nephrectomy followed by hemodialysis in a patient. In three patients, the final diagnoses were confirmed by autopsy.

Their presenting symptoms varied depending on the stage of progression of the each patient. However, abdominal, lumbar or loin pain, hematuria and hypertension were the most common symptoms. Ten percent of the patients had chief complaints unrelated to the urinary system, such as hepatomegaly or right hypochondrial pain. The diagnosis of polycystic kidneys on these patients was made secondary, after polycystic liver disease was pointed out as initial diagnosis. A definite family history of polycystic disease was obtained in 9 families of our series.

METHODS

Our study includes excretory urography, radionuclide scanning, ultrasonography, computed tomography, and angiography. Renal scanning was performed in all patients and liver scanning in 60 patients. The scanning on spleen, pancreas, and lungs were performed in limited cases.

The HP or LFOV type gamma camera (Nuclear Chicago) was used for radionuclide scanning. As listed in Table 1, ^{99m}Tc-DMSA or ^{99m}Tc-PAC was used mainly for renal imaging and ^{99m}Tc-phytate or ^{99m}Tc-colloid for liver imaging. Spleen imaging was obtained by Tck-11 or ^{203}Hg-MHP (5 cases), pancreas imaging by ^{75}Se-

selenomethionine (2 cases), and lung imaging by ^{99m}Tc-MAA (3 cases). Aloka 120 or Toshiba SAL 10A was used for ultrasonography. ACTA 0100 was used for computed tomography.

RESULTS

Excretory urography was performed in 56 cases. Thirty-nine of them had typical findings of polycystic kidneys on excretory urogram. However, 17 patients failed to show contrast media on excretory urogram, because of poor kidney function. Incidentally, renal calculus was found in 8 patients and calcification of cyst wall in 3 patients. In 4 patients, duplication of renal pelvis and ureter was found. In a patient, unilateral renal angiomyolipoma was associated with polycystic kidneys, the diagnosis of which was confirmed by surgical exploration and biopsy.

The comparison among radionuclide study, ultrasonography, computed tomography, and angiography as to diagnostic value of this lesion is summarized in Table 2. Radionuclide study failed to demonstrate polycystic lesion of the kidneys in 2 patients. Dynamic studies with ^{99m}Tc-DTPA and static studies with ^{99m}Tc-DMSA on these patients, also failed to identify kidneys. However, the other three studies successfully detected polycystic lesion of the kidney. These 2 patients revealed significantly impaired renal function, with serum creatinine 11.3 and 9.7 mg per 100 ml and blood urea nitrogen (BUN) 141 and 103 mg per 100 ml, respectively.

Table 1. Scanning agents.

1) Renal imaging	
* ^{99m}Tc-DMSA	33 cases
^{99m}Tc-PAC	22
^{131}I-hippuran	9
^{99m}Tc-DTPA	6
	70 cases
2) Liver imaging	
^{99m}Tc-phytate	30 cases
^{99m}Tc-colloid	25
^{198}Au-colloid	3
	58 cases

* ^{99m}Tc-DMSA; ^{99m}Tc-dimercaptosuccinic acid, ^{99m}Tc-PAC; ^{99m}Tc-penicillamine acetazolamide complex, ^{99m}Tc-DTPA; diethylene triamine pentaacetic acid.

Of the 60 patients, who had investigation of the liver, 37 patients (61.6%) demonstrated polycystic lesion of the organ (Fig. 1,2,3). On the other hand, only one of 7 patients (14%) noted polycystic lesion of the spleen.

Intracranial arteriography was performed in 7 patients who had severe hypertension and complaints related central nervous

Tabe 2. Radiological findings of polycystic lesion in 70 cases.

	NM		US		CT		AG	
	Px	Nx	Px	Nx	Px	Nx	Px	Nx
KIDNEY	68	2	21	0	12	0	25	0
LIVER	38*(65)	20	17(71)	7	6(55)	5	6(75)	2
SPLEEN	0	6	1	0	–	–	1	0
PANCREAS	0	1	–	–	–	–	–	–
LUNG	0	3	–	–	–	–	–	–
ANEURYSM OF CEREBRAL ARTERY	–	–	–	–	–	–	0	7

NM NUCLEAR MEDICINE
US ULTRASOUND
CT COMPUTED TOMOGRAPHY
AG ANGIOGRAPHY

Px POSITIVE CASE
Nx NEGATIVE CASE
*( ) % POSITIVE

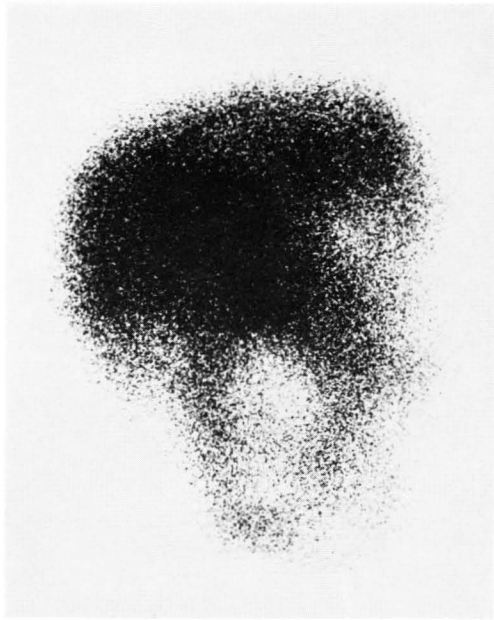

Fig. 1. A example of polycystic liver. The right lateral view of ^{99m}Tc-phytate liver scan.

Fig. 2. Transverse ultrasonogram shows polycystic lesion in the liver.

Table 3. Polycystic lesions in the other organs.

1) investigation of liver		
	not performed	10 cases
	performed	60
	positive	37 (61.6%)
	negative	23
2) investigation of spleen		
	not performed	63 cases
	performed	7
	positive	1 (14 %)
	negative	6
3) investigation of aneurysm		
	not performed	61 cases
	performed	9
	positive	0 (—)
	negative	9

Table 4. Creatinine clearance and serum creatinine level.

1) Ccr (L/DAY)	
range : 4.5 – 241.3	
100 -	11 (24 %)
50 - 99	11 (24)
20 - 49	14 (33)
10 - 19	6 (13)
5 - 9	1 (2)
- 8	2 (4)
total	45 (100)
2) serum creatinine level (MG/DL)	
- 1.5	39 (56 %)
1.6 - 2.0	7 (10)
2.1 - 3.0	8 (11.4)
3.1 - 4.0	4 (5.7)
4.1 - 5.0	2 (2.8)
5.1 - 6.0	4 (5.7)
6.1 - 7.0	1 (1.4)
7.1 - 8.0	0 (0)
8.1 - 9.0	1 (1.4)
9.1 - 10.0	2 (2.8)
10.1 - 11.0	1 (1.4)
11.1 - 12.0	1 (1.4)
total	70 (100 %)

system. None of them, however, revealed aneurysmal change (Table 3).

DISCUSSION

Polycystic kidney disease is a structural disorder that results in the conversion of a perceptible portion of the renal parenchyma into cysts of various size, and is divided into two major types; infantile and adult type[1]. Adult polycystic disease of the kidney is generally known to be a progressive, frequently familial, and bilateral cystic degeneration. The progression of this disease is divided into three main stages; the asymptomatic, the symptomatic, and the uremic. Usually themajority of patients die in the fifth, sixth, or seventh decade by renal failure or aneurysm rupture.

On diagnosis of this disease, preliminary estimation of renal function is essential. Table 4 shows creatinine clearance in 45 patients and serum creatinine level in 70

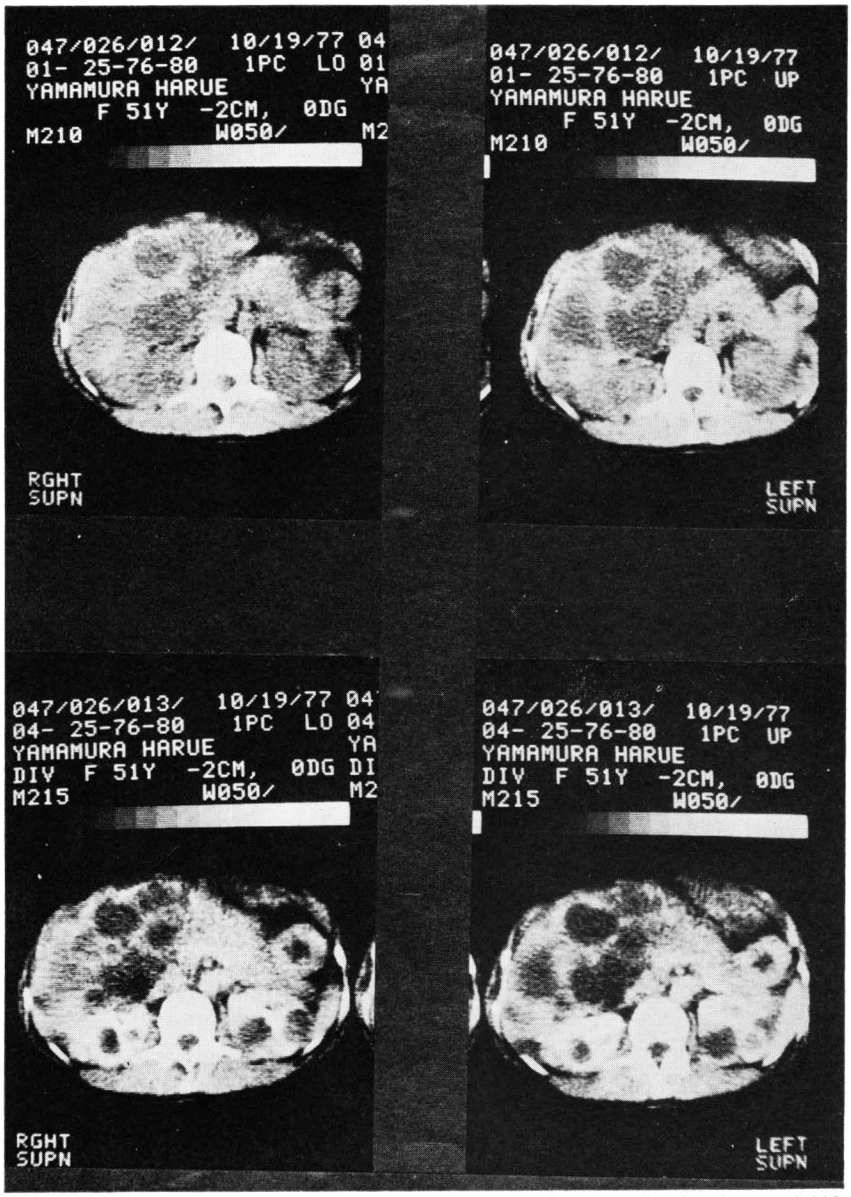

Fig. 3. Scans taken at 2 cm intervals demonstrate polycystic lesions in the liver and kidneys

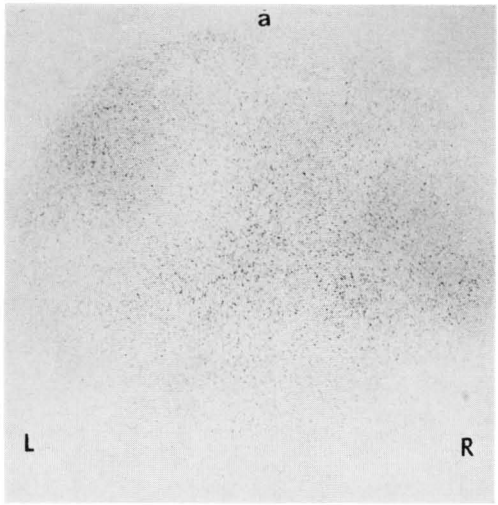

Fig. 4a. ^{99m}Tc-DMSA scan.

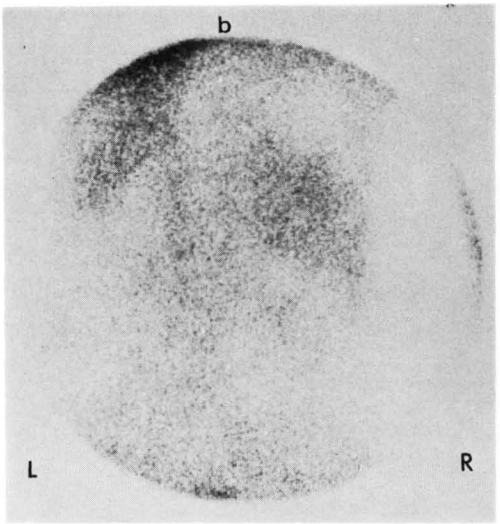

Fig. 4b. ^{99m}Tc-DTPA scan.

(Unidentified group)

patients of our series. These tests were done within 2 weeks before and after the renal radionuclide studies were performed. In our series, 31 of 70 patients (44%) revealed abnormal serum creatinine level, over 1.5 mg per 100 ml, the highest being 11.3 mg per 100 ml. In 23 of 45 patients (51%), creatinine clearance marked under 50 L per day. In other words, about a half of our series had impaired renal function of various degrees.

The renal images were evaluated and classified into the following four groups; Excellent, Fair, Poor, and Unidentified. A sample case of the each group is introduced as following.

CASE 1. The image of this 56-year-old female (Fig. 4a) is classified as Unidentified. The kidneys are not visualized on this image. The dynamic study using ^{99m}Tc-DTPA (Fig. 4b), which was done before ^{99m}Tc-DMSA study, also demonstrated no kidneys, but the image of liver, spleen, and bones. The diagnosis of this case was made by ultrasonography and computed tomography

CASE 2. The renal image of this 71-year-old male is classified as Poor image group (Fig. 5). Renal contour is not clear and multiple large cold areas are seen. Radionuclide scanning alone is not satisfactory enough to confirm diagnosis in this case.

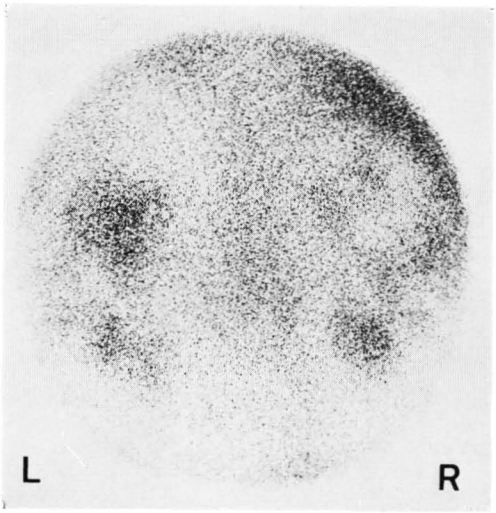

Fig. 5. ^{99m}Tc-DMSA scan (Poor image group)

CASE 3. The renal image of this 39-year-old male is classified as Fair image group. This group is situated between Excellent and Poor image group (Fig. 6).

CASE 4. This 61-year-old female is a case of the Excellent image group (Fig.7). This group has clear renal contour, multiple small or moderate sized cold areas, and is easily diagnosed as polycystic kidneys.

Throughout our series, two kinds of scanning agent were used mainly for renal radionuclide static study, ^{99m}Tc-PAC (22 cases) in the begining and ^{99m}Tc-DMSA

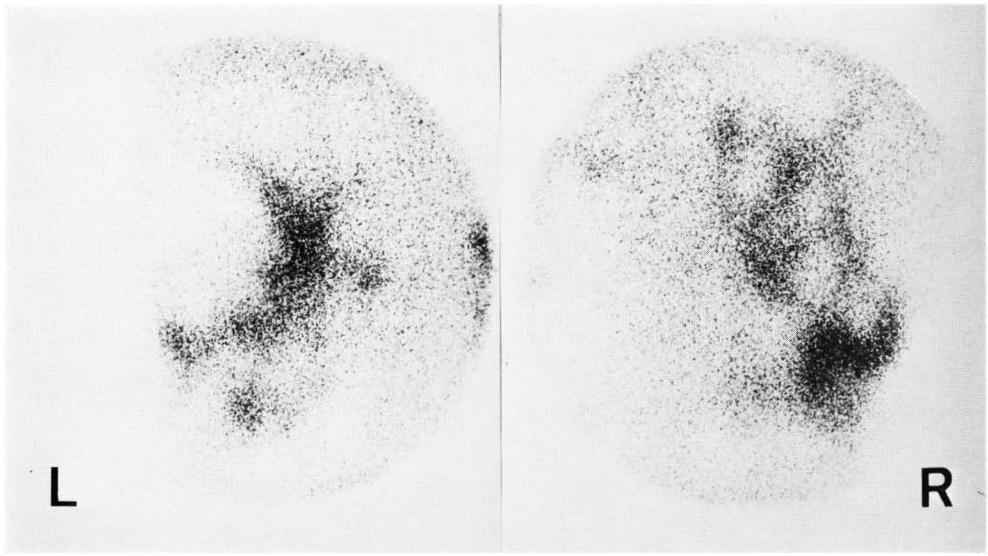

Fig. 6. ^{99m}Tc-DMSA scan (Fair image group).

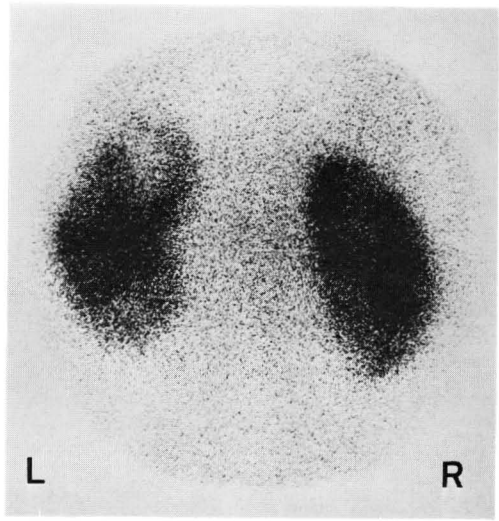

Fig. 7. ^{99m}TcDMSA scan (Excellent image group).

(33 cases) lately.

The diagnostic value of these two scanning agents are grossly similar and provide excellent scan images at the renal cortex even in patients with impaired renal function[2~4]. The correlation between renal function and renal image of ^{99m}Tc-DMSA series is listed in Table 5, and that of ^{99m}Tc-PAC series is listed in Table 6, respectively. The sum upped data of these two series are listed in Table 7.

The difference between the means of serum creatinine or BUN in each group has been verified by statistical analysis (t-distribution). In all patients of the Poor and Unidentified groups and 5 of the Fair group, excretory urography did not contribute to diagnose this lesion. Ultrasonography and/or computed tomography were employed on those patients to confirm diagnosis. As the upper limits of serum creatinine and BUN value, within which one may expect to obtain satisfactory renal image to diagnose the polycystic kidneys, we conventionally prefered sum upped figures of the mean and a standard deviation of the Fair image group; 4 mg per 100 ml in serum creatinine and 50 mg per 100 ml in BUN (Fig. 8 and Fig. 9).

Tannenberg[5] reviewed radionuclide scans of patients with varying levels of renal insufficiency using ^{203}Hg-chlormerodrin, defined three scan grades, and concluded that a good scan may be obtained if serum creatinine or BUN is less than 2.4 mg per 100 ml or 39 mg per 100 ml respectively.

Rosenthall[6] and Staab et al.[7] also reported similar estimations using ^{131}I-hippuran. Beside these, a lot of radiological and pararadiological studies have been presented in recent years in regard to the visualization of the renal image in remal insufficiency. The diagnostic usefulness of combined study with ultrasonography and

Table 5. Correlation between renal imaging by ^{99m}Tc-DMSA and renal function in #33 cases.

evaluation of image	No. of patients	serum creatinine	blood urea nitrogen
Excellent	17	R: 0.5–2.2 1.14± 0.52	R: 12–34 19.2± 6.3
Fair	8	R: 1.1– 5.3 2.6 ± 1.4	R: 14–59 32.8± 13.8
Poor	6	R: 4.1– 9.5 6.03± 1.96	R: 49–96 65.2± 18.2
Unidentified	2	R: 9.7–11.3 10.5 ± 0.8	R:103–141 122 ± 19

* Indicating ranges, mean values, and standard deviations in milligrams per one-hundred milliliters.

Table 6. Correlation between renal imaging by ^{99m}Tc-PAC and renal function in 22 cases.

evaluation of image	No. of patients	serum creatinine	blood urea nitrogen
Excellent	13	R: 0.5–2.5 1.07±0.58	R:13–30 19.8± 5.1
Fair	6	R: 1.5–4.2 2.92±0.95	R:20–53 38.7± 10.6
Poor	3	R: 5.7–8.3 6.7 ±1.14	R:60–87 70.7± 11.7
Unidentified	–	–	–

*Indicating ranges, mean values, and standard deviations in milligrams per one-hundred milliliters

Table 7. Correlation between renal imaging and renal function in 55 cases.

evaluation of image	No. of patients	serum creatinine	blood urea nitrogen
Excellent	30	R: 0.5– 2.5 1.11±0.54	R: 12–34 19.4± 5.7
Fair	14	R: 1.1– 5.3 2.74± 1.18	R: 14–59 35.3± 12.3
Poor	9	R: 4.1– 9.5 6.26± 1.63	R: 49–96 67 ±15.4
Unidentified	2	R:9.7– 11.3 10.5 ±0.8	R:103– 141 122 ± 19

*Indicating ranges, mean values, and standard deviations in milligrams per one-hundred milliliters.

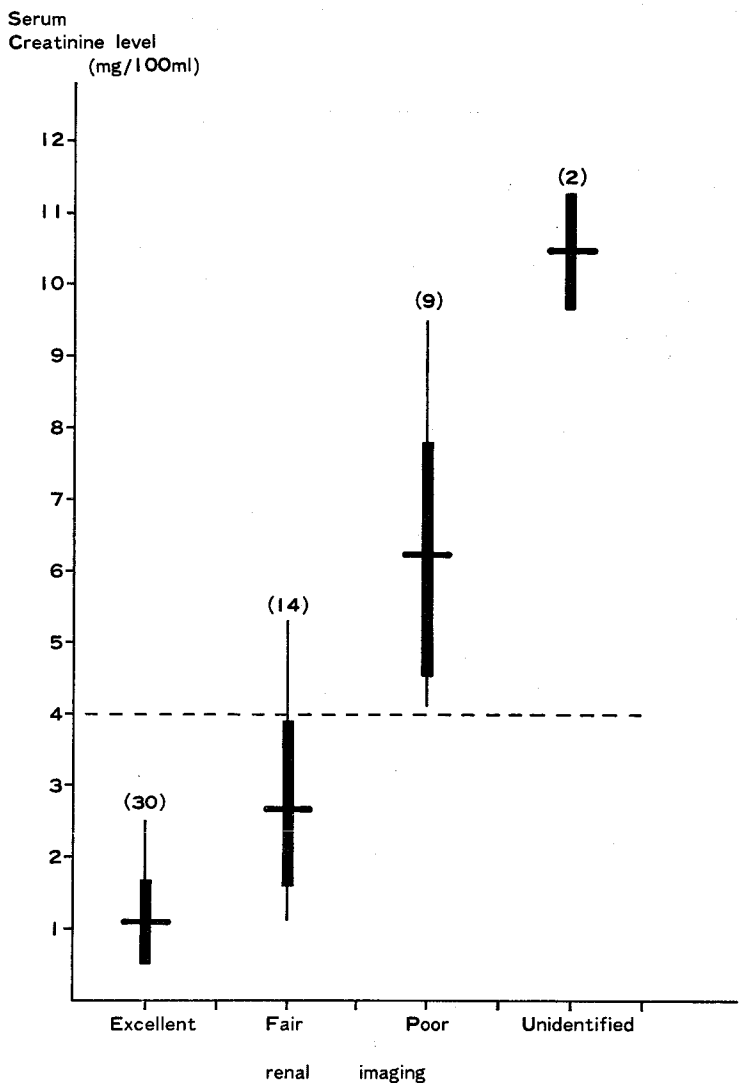

Fig. 8. Correlation between serum creatinine level and renal imaging. The meanvalues and standard deviations are demonstrated. The number in parenthesis indicates number of the patients in each group.

renal radionuclide study in polycystic disease has been stressed by Sanders et al.[8,9] On the other hand, Sagel[10] and Levitt[11] have emphasized the specific advantage of computed tomography in the diagnosis of polycystic kidneys in their articles.

Rothermel[12] has described the clinical usefulness of ^{67}Ga-citrate study and angiography in evaluation of focally infected polycystic kidneys. In our series, 23 patients were investigated by ^{67}Ga-citrate because of suspicious abscess in their polycystic kidneys and 12 patients received appropriate treatment.

Search for polycystic lesion of the liver was done in 60 patients of our series. In 37 patients (61.6%) polycystic lesions of the liver were found by liver scan and other radiological examinations. None of them presented clinical signs of liver dysfunction.

The incidence of associated polycystic liver in patients with polycystic kidneys ranges from 30 to 50 percent in most literatures[1,13~15]. On the other hand,

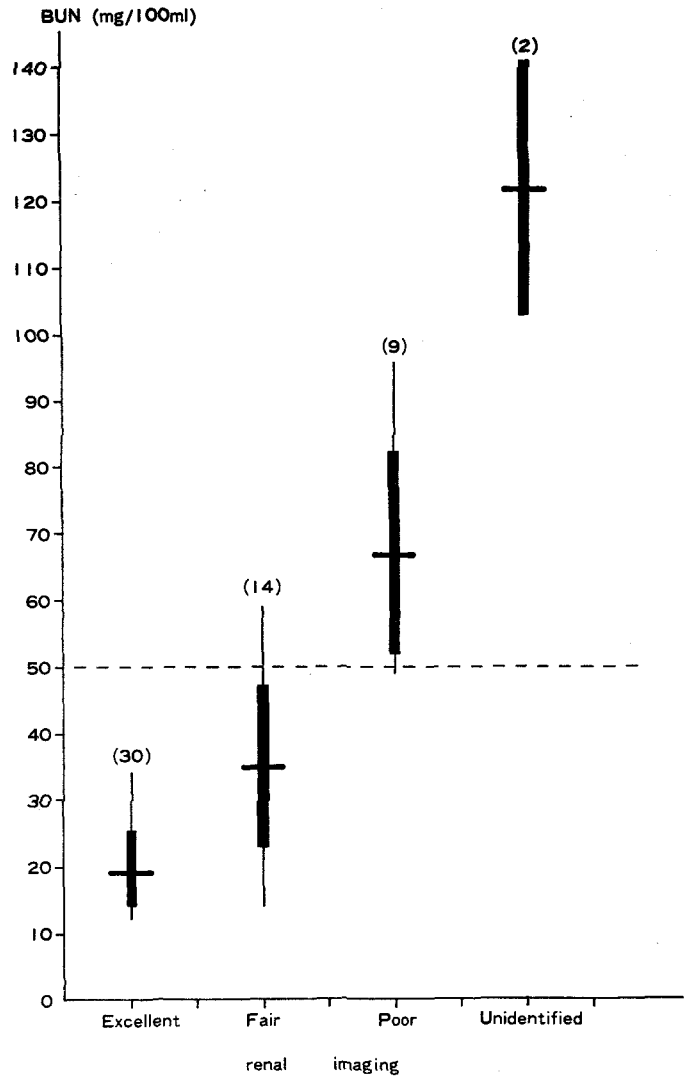

Fig. 9. Correlation between blood urea nitrogen and renal imaging. The mean values and standard deviations are demonstrated. The number in parenthesis indicates number of the patients in each group.

Melnick and his associates[16] have reported 70 cases of polycystic liver and found 35 cases (50%) of polycystic kidneys as associated condition. In Japan, 187 cases of polycystic disease of the liver and the kidney were reviewed by Hasumi et al.[17] and they reported the co-existing cystic formation in 7 cases in pancreas, 6 in ovarium, 2 in spleen and 1 in prostate, uterus, esophagus, and thymus respectively.

These polycystic lesions are commonly silent, as long as the sizes of cysts are not large enough to impair the function of the proper organ or compressing the surrounding structures.

The authors believe that radionuclide study combined with ultrasound and computed tomography is a helpful addition in diagnosis of this disease.

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和文抄録

嚢胞腎の形態診断（核医学診断を中心に）

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嚢胞腎，70例について，その統計学的観察とともに，嚢胞腎の形態診断における，腎シンチグラムの有用性について，超音波断層法，コンピュータ断層撮影など，他の放射線診断法との比較もまじえて，検討した．また，他臓器に合併した嚢胞性病変に対する検索も行ない，嚢胞腎の臨床診断における総合イメージ診断の意義について考察した．

嚢胞腎は，病変の進行度により，臨床的に無症候性，症候性および尿毒症の3つの病期に分けられ，その形態診断に際しては，腎機能障害の有無が問題になる．著者は，^{99m}Tc-PAC および ^{99m}Tc-DMSA による腎シンチグラフィーでの腎イメージの描出度を4つの Grade に分類し，それぞれの Grade と腎機能を対比するとともに，他の形態診断法と比較検討し，1）腎機能がほぼ正常範囲内の場合，排泄性尿路造影と腎シンチグラフィーにより嚢胞腎の形態診断を得るのに充分な情報を得ることができる．2）腎機能低下を認める場合，特に血清クレアチニン値，4.0 mg/dl 以上，あるいは BUN, 50 mg/dl 以上を呈しているような場合は，まず，腹部単純撮影により，腫大した両側の腎陰影を確認した後，超音波断層法，またはコンピュータ断層撮影により，両側の多発性嚢胞性病変を確認した後，充分な腎イメージは期待できないが，腎シンチグラフィーにより腎全体のイメージおよび残存腎実質を把握することが理想的である．との結論を得た．いずれにしても，腎機能への依存性が少なく，しかも被検者への侵襲性の少ない超音波断層法が，すぐれていると思われるが，反面，再現性に乏しいなどの欠点も認められた．

他臓器に合併した嚢胞性病変については，おもに肝について，肝シンチグラフィーおよび超音波断層法などにより検索し，60例中，37例（61%）に，肝の嚢胞性病変が認められた．いずれの症例においても，肝腫大のほかには，特に肝機能障害，門脈圧亢進などの所見は認められなかった．嚢胞腎における多発性肝嚢胞の合併頻度は，ほとんどの報告で，30%から50%の範囲にあり，著者のシリーズでは，ややそれを凌駕した．このように，嚢胞腎の形態診断に際して，腎外臓器の嚢胞性病変，特に，脳動脈瘤に対する配慮が重要であるが，逆に，肝をはじめとするそれらの臓器を検索することにより，さらにその診断精度が増すものと思われる．