Renal Functions in Hypertensive Subjects Evaluated by Computer-aided Radioisotope Renogram

AKINA HIRAKAWA, KOICHI OGINO, MASATO MATSUNAGA,
AKIRA HARA, MUNEYASU SAITO, SEIICHIRO SAITO,
AND TSUNETARO SAKURAI

1. SIX YEAR'S Death Rate in Patient with Hypertensive and/or Parenchymal Renal Diseases

Those who had ^{131}I -Hippuran renography tests in 1967 with the age of more than thirty, and with neither sign of neoplasma, pyelonephritis, hydronephrosis, urolithiasis, tuberculosis, GY diseases, benign prostata hypertrophy, polycystic diseases nor other so-called urological diseases, were re-examined by the interview whether they were alive or dead. Out of 277 cases reexamined, we could reach 219 cases, while we could not establish communications with the rest of 58 cases as shown in Table I.

Two hundred nineteen cases were divided into four groups in terms of blood pressure and albuminuria, and the distribution of the ages was statistically examined as shown in Table II., which turned out to be equivalent in each group. The six year's death rate was shown in Table III, which revealed that (1) contribution of the factor "hypertension" to the death rate is highly significant with the level of significance of 0.01, and (2) contribution of the factor "albuminuria" to the death rate is also significant with the level of significance of 0.05.

2. Renal Functions in Normal Subjects Measured by Digital Simulation of ^{131}I -Hippuran Renogram and ^{131}I -Na Iothalamate Renogram with Concomitantly Measured 25 Minutes Excretion Rate

RPF's were measured by digital simulation of ^{131}I -Hippuran renograms with concomitantly measured 25 minutes excretion rate based on a model proposed by authors^{1,2} as shown in Fig. 1. The model consisted of two major parts, (1) distribution space for radioisotope which expands dynamically from 2.0 liters to around 12 liters in 25 minutes which is a principal factor to determine plasma concentration of the RI, (2) a first order system with transportation delay time which corresponds to the transportation process of the RI in the kidney. As shown in Fig. 2, after semiautomatic simulation of radioisotope renograms and simultaneously of 25 minutes excretion rate observed, parameters, such as RPF, its right to left ratio, mean transit time of the RI in the kidney, right and left respectively, can be utilized on the same base of PAH clearances.

GFR's were also measured by the same principle from ^{131}I -Na Iothalamate renograms with concomitantly measured 25 minutes excretion rate.

In ten normal subjects, RPF were 565 ± 66 ml/min, GFR 117 ± 16 ml/min, and FF 0.02 ± 0.007 . FF were rather pressure-independent and distributed in a narrow range as shown in Table IV.

3. Renal Functions in Primary Aldosteronism

In the past one year, there were five cases of primary aldosteronism, and their FF's were 0.14, 0.14, 0.17, 0.17, and 0.18 respectively, signifi-

Department of Internal Medicine, Kyoto University School of Medicine, Kyoto, Japan

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Fig. 1. Proposed Model for Transportation Process of RI in RI-Renography.

TABLE I LIST OF CASES INTERVIEWED SIX YEARS AFTER THE RI-RENOGRAPHY TESTS IN 1967

	AGE	MBP	RPF	Case
1. Group 1. Hypertension + Albuminuria				32
Alive	49.1 ± 12.5	115.7 ± 15.5	350 ± 142	16
Dead	54.1 ± 10.9	120.9 ± 18.2	$224 \pm 145^*$	10
Unknown	56.8 ± 16.0	117.8 ± 11.7	206 ± 121	6
2. Group 2. Albuminuria only				32
Alive	49.8 ± 14.1	87.7 ± 9.9	430 ± 140	24
Dead	42.7 ± 9.0	85.0 ± 4.4	$143 \pm 121^{**}$	3
Unknown	36.2 ± 5.9	81.0 ± 9.4	324 ± 216	5
3. Group 3. Hypertension only				93
Alive	50.5 ± 10.8	116.1 ± 11.6	455 ± 136	59
Dead	$62.7 \pm 8.4^{***}$	115.7 ± 14.2	$333 \pm 125^{**}$	15
Unknown	49.2 ± 11.2	111.8 ± 10.1	444 ± 119	19
4. Group 4. Neither hypertensive nor albuminuric				121
Alive	50.5 ± 11.0	88.8 ± 10.5	468 ± 120	86
Dead	$61.0 \pm 14.0^{**}$	84.2 ± 18.0	452 ± 163	6
Unknown	48.6 ± 11.3	88.5 ± 10.8	508 ± 106	29

(Mean $\pm$ Standard Deviation) $^*p < 0.005$ $^{**}p < 0.01$ $^{***}p < 0.001$

RI-RENOGRAM REPORT

***** OBSERVED RENOGAM
 ===. IIIII COMPUTED RENOGAM

469 COMPUTER-AIDED RI-RENOGRAM DIAGNOSIS (RPF)
 DATE 740603 NAME ARATA MASAMITI # AGE
 UNIT DIAGNOSIS

CHART#

BP R. / , L. / , URINE FLOW ML/MIN

OCCULT BLOOD , PROTEIN , SUGAR , SP. GRAV. 10

MINUTES : RIGHT

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MINUTES : LEFT

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=====PROBES AT L(), R()CM ABOVE ILIAC CREST==
 TOTAL RPF= 615 ML/MIN. (R/L 50.5/49.5) BG. R= 100 L= 100
 EXCRETORY TIME CONSTANT R= 1.6(.5)MIN L= 1.3(.7)MIN
 DEAD TIME R= 2.0 MIN L= 2.0 MIN
 MEAN TRANSIT TIME R= 3.6 MIN L= 3.3 MIN
 EXCRETION OBSERVED(25MIN)=73.5% (50MIN)=79.7%
 EXCRETION COMPUTED(25MIN)=73.5% ACCURACY R= .7 L= 1.7
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Fig.2. Digital simulation of RI-Renograms and of observed 25 minutes excretion rate.
 Observed renograms were superimposed by the computed renograms.

TABLE II DISTRIBUTION OF AGES IN CASES WITH THE ESTABLISHED COMMUNICATIONS

	Albuminuria		Non-albuminuria	
Hypertensives	51 ± 12	(N = 26)	53 ± 11	(N = 74)
Non-hypertensives	49 ± 14	(N = 27)	51 ± 12	(N = 92)

TABLE III SIX YEAR'S DEATH RATE

Number of Cases				
Hypertensives**			Non-hypertensives	
	Albuminuria (+)*	Albuminuria (-)	Albuminuria (+)*	Albuminuria (-)
Dead	10 (38%)	15 (20%)	3 (11%)	6 (7%)
Alive	16	59	24	86
Total	26	74	27	92

**p < 0.01 *p < 0.05

TABLE IV NORMAL VALUE OF RPF, GFR, FF (RI-RENOGRAM)

	Age	Sex	RPF	GFR	FF	BP
(1)	35	F	590	129	0.218	132/82
(2)	24	F	550	111	0.202	90/50
(3)	39	F	535	107	0.200	98/60
(4)	63	F	505	109	0.216	132/90
(5)	39	M	605	127	0.207	110/80
(6)	21	M	590	122	0.207	120/70
(7)	44	M	555	113	0.204	120/78
(8)	18	F	715	154	0.215	118/82
(9)	32	F	485	99	0.204	120/80
(10)	53	F	515	101	0.196	102/50
(M ± SD)			565 ± 66	117 ± 16	0.207 ± 0.0073	

cantly lower than normal values. In one case, as shown in Fig. 3., after the removal of hormone releasing tumor, FF was returned to normal, 0.21, with simultaneous decrease of RPF from 460 to 300 ml/min. Renin activity was also null before the operation, which returned to normal range after the operation. Therefore we can conclude that, renin is, or may be, responsible to

maintain FF in a normal range, or in proper value by depression of RPF and elevation of GFR.

4. Renal Functions in Essential Hypertensions

Nineteen cases with essential hypertension were examined in the past one year, and their FF's were compared to the level of mean blood pressure. As shown in Fig. 4., their FF's were

E.I. 36 f. Primary Aldosteronism

Fig.3. Renal functions pre- and post-operative period in case with proven primary aldosteronism.

Fig.4. Filtration fraction in patients with essential hypertension.

pressure dependent. There were statistically significant differences between each levels. When blood pressure is over 115 mmHg, their FF's were 0.224 ± 0.016 , higher than normal value, which was compatible with the results observed in another institutions. But in patients with slightly elevated blood pressures or almost

normal blood pressures on the test revealed lower FF's, which remained to be surveyed further.

5. Conclusions

(1) In 219 cases with or without hypertensive and/or renal parenchymal diseases, six year's death rate was examined, whereby "hyperten-

sion" and "albuminuria" turned out to be risk factors.

(2) In primary aldosteronism, their FF's were pretty low, suggesting that the renin might be responsible for the active control of GFR in a normal range.

(3) In normal subjects, their FF's were kept narrow range, 0.20 to 0.21.

(4) In patients with essential hypertension, their FF's were pressure-dependent.

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