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Some remaining problems of aldosteronism from personal case

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RIGHT:
SOME REMAINING PROBLEMS OF ALDOSTERONISM
FROM PERSONAL CASE

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(Director: Prof. S. Suzuki)

I. PREFACE

Simpson and Tait (1952) extracted aldosterone from an excised adrenal and determined on its chemical formula. Not long after then Conn (1955) reported the first case of primary aldosteronism. It has been eleven years since he established the concept of hyperaldosteronism. In the meantime many cases of primary aldosteronism and pathology of hyperaldosteronism have been brought to light pathologically to a great extent.

Recently renin-angiotensin system has been studied. And it has been made clear that renin-angiotensin, a hypertensive substance, that is secreted from the kidney, will induce the secretion of aldosterone in the case of renal hypertension. Speaking of hypertension, the relation between the renal hypertension and aldosterone has especially attracted so much attention.

Not only nephrosis, cirrhosis of the liver, and the edema following cardiac failure that in the first place was thought to be the primary factor of secondary aldosteronism, but also potassium-losing renal diseases and certain hypertensions (in renal hypertension and malignant hypertension) are of this category. Thus at present it is thought to be important to differentiate secondary aldosteronism from primary aldosteronism cases of hypertension that have analogy with Conn’s syndrome.

Wrong (1957) diagnosed the case of a 52-year-old man as primary aldosteronism for his hypertension, hypokalemic alkalosis, and increase of aldosterone in his urine before operation, after which, quite contrary to his expectation, he could find no histological abnormality in either adrenal. Hyperaldosteronism was not of an adrenal origin. He reported his successful treatment of a case of secondary aldosteronism with the ischemic kidney. Since his report we have heard of no more than thirty cases of hyperaldosteronism of the renal origin in medical literatures up to date.

We, having concluded our diagnosis of this case as secondary aldosteronism brought about by the renal tuberculosis, present the clinical findings from this examination and the inquiry into the literature concerning this disease.

II. PERSONAL CASE

Patient (T. Y.) was a 38-year-old man. Family history revealed nothing of impor-
tance. Past history showed that he was undergone an operation because of bilateral tuberculous epididymitis at the age of 31. Present illness revealed that during the past two years, he has complained of fatigue, polydipsia and headaches. Physical examination demonstrated that he was moderately well nourished man without edema. Blood pressure ranged from 160/100 mmHg and the fundoscopy showed KW I, but the otherwise was non-contributory.

Laboratory Findings:
1) Blood:
- Red blood cells: 594 x 10^4, white blood cells: 8200, segmented neutrophils 49%, band neutrophils 4%, monocytes 6%, eosinophils 3%, lymphocytes 38%, Hb: 15.0 g /dl, Ht: 41%. Plasma volume (RISA) 56.9 mg/kg, bleeding time: 3', clot retraction: 43%, prothrombin time: 100%, fibrinogen: 400 mg/dl, fibrinolysis: normal.

2) Blood chemistry
- Urea: 17 mg/dl, NPN: 33.8 mg/dl, creatinine: 2.1 mg/dl, sp. gravity 1.027, total protein 6.4 g/dl, A/G: 1.67, Cl 102.8 mEq/L, Na 139 mEq/L, K 3.8 mEq/L, Ca 4.9 mg/dl, Mg 2.25 mEq/L, cholesterol (total) 179.5 mg/dl, cholesterol ester 70.5%, Welmman reaction 0.3%, thymol turbidity test 2.3, Meulengracht index 5.8, bilirubin (total) 0.8, alkaline phosphatase 8.9 King-King unit, acid phosphatase 4.3 Kind-King unit, GOT 21.5, GPT 17, LDH 225.

It is noted that potassium shows a little lower value than the normal limit, while Na, Cl and Mg stay within the normal.

3) Serum protein fraction
- Al: 30.0%, Gl: α1-5.2%, α2-16.1%, β 14.3%, γ 34.4%.

4) Serologic tests
- ASLO: 100 units, VDRL and complement fixation, nonreactive.

5) Acid-base balance
- pH 7.5, Ht 35%, Pco2 34 mmHg, Buffer Base 48 mEq/L, CO₂ cont. 42 vol %, O₂ cont. 19.1 vol %. The blood gas percentage and the acid-base balance both stand within the normal limits.

6) Urinalysis
- volume: 950–2400 ml/day, specific gravity: 1.008–1.020, pH: 5.6. albumin (+), sugar (−), urobilogen normal, sediment: red blood cells (−), white blood cells (−), casts (−). Na: 117 mEq/day, K: 15.75 mEq/day. Urine culture: negative. Na, K percentages both stand lower than the normal limits.

7) Saliva
- Cl (mEq/L) I 44.1 II 38.3 III 44.9
- Na (mEq/L) I 66.5 II 76.5 III 76.5
- K (mEq/L) I 8.0 II 5.0 III 4.9
- Ca (mEq/dl) I 6.3 II 7.0 III 7.45

The saliva reveals K and Na rather low, and Ca just normal and Cl rather high in terms of percentage.

8) Function tests of the endocrines
- BMR: +7 %, Thorn test: 67 %, regitine test: negative, urinary 17 KS, 10.4 mg/day, 17 OHCS 7.2 mg/day.

The hypothalamic depressant test (by ACTH, Metopirone) showed the following results (Fig. 1 & 2).

Urinary catecholamine (by laboratory of medicine faculty of Tokyo University. : Director, Prof. Yoshitoshi) A-3.4 μg/day, NA-17.1 μg/day, VMA-0.36 mg/day.

Urinary aldosterone (Nippon University: Director, Prof. Oshima) 20.7 μg/day.

Response of potassium administration

By means of administration of Spirono-
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Bevore Administration

<table>
<thead>
<tr>
<th>Urine</th>
<th>Na (mEq/day)</th>
<th>K (mEq/day)</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Potassium Administration</td>
<td>Potassium Administration</td>
</tr>
<tr>
<td></td>
<td>315</td>
<td>16.8</td>
<td>304.1</td>
<td>42.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blood</th>
<th>Na (mEq/L)</th>
<th>K (mEq/L)</th>
<th>141</th>
<th>129</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.3</td>
<td>4.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

lactone (Aldactone A) serum potassium rose to 4.4 mEq/L.

9) Fundoscopy : KW I
Orthostatic hypertension negative, ECG: no abnormal findings.
EEG: borderline, EMG: normal.
Angiotensin II infusion test showed 15.7 milimicro gram per kilogram per minute and the rise in BP (diastole) was 20 mmHg.

10) Renal function tests
PSP test: 15° 10%, 70° 60%. Dilution and concentration test: 945 cc at 4 hr. specific gravity 1.010-1.020, creatinine clearance: 76.6 cc/min. Howard test, Renogram indicated no difference between the left and the right kidney.

11) Urological examinations
Cystoscopy: no pathologic findings. Indigocarmine test: R 3'10'', L 2'55''-3'05'' IP (Fig. 3), PRP and nephrotomography (Fig. 5) found dark shadows suggesting tumor around the right adrenal border of the right renal upside margin, but the segmental aortography (Fig. 4) revealed no calcium plaque in the renovascular branches.

The above clinical findings and other tests, especially the increase of aldosterone as well as hypokalemia, hypertension, nocturia, results of roentgenological examinations all compelled us to diagnose this case as primary aldosteronism.

III. OPERATION

We attempted adrenalectomy on this patient by thoraco-lumbar approach under the general hypothermal anaesthetization. We found that the right adrenal was adhered retroperitoneally (behind the liver). Its basic margin touched V. cava inferior, and V. renalis. Moreover no isolated adenomas were discovered grossly.

And as the upper pole of the right kidney was firmly adhered to the renal surface of adrenal, having a remarkably hard lobulated form, we were compelled to perform total adrenalectomy and nephrectomy.

IV. PREOPERATIVE MANAGEMENT AND ANESTHETIZATION

In order to raise the patient's serum potassium level before the contemplated operation, Aldoctone A 300 mg, was administered for nine days and KCl (24 tablets a day) for six days, to the patient, which resulted in 5.3 mEq/L of potassium level.

Method of Anaesthesia: G. O. P. Hypothermia with blanket cooling semiclosed method.

Gas machine: Octavian- No. 1, with the vaporizer (pentec) outside the circle.

Premedication: Neblizer, Alevaire 5 ml (twice), Ional sodium 50 mg (3 times), Opystane 35 mg×2A (intramuscular injection) Atropin. sulf. 0.5 mg (intramuscular injection).

Process: The effect of the premedication was considerable, for the patient showed no particular excitement at the time of entering the operation room, with blood pressure at 152-104, pulse at 83/min., respiration at 20/min. Induction was slowly
carried out with penthrane 0.5–1.0–1.5%, N₂O 3L/min., O₂ 3L/min. on the patient under our close watch. The patient was intubated after one hour and thirty minutes. In the meantime the respiration was quite spontaneous with the pulse constant at 80/ min., while the blood pressure was abated only a little. The maintenance of the condition was kept with the constant supplies of penthrane 1%, N₂O 3L/min. throughout the operation. At the end of the operation the supplies of penthrane and N₂O were cut off to keep up O₂ at 5L/min.

Cooling was started after intubation and was kept up until operation was begun, while the body temperature went down from 36°C to 33°C after one hour, when the operation was carried out. The patient was quite at ease with blood pressure at 110–80 mmHg, pulse at 65/min. and the assisted respiration.

Rewarming was done for about one hour and forty minutes and the rectal temperature was raised form 32.2°C up to 34°C, after which it returned to be 35.8°C through natural rewarming at 8 p.m. The after drop during the sustained anaesthetization was 0.8°C, and the record low at the end of operation was 32.2°C.

Operation: Cooling was discontinued at the body temperature of 33.0°C, when the operation was started. Operation took two hours and thirty minutes. Adrenalectomy was carried out two hours after operation started. The patient kept a stable condition with blood pressure at 115–85 mmHg, pulse at 65–75, with assisted or spontaneous respiration.

Recovery: After operation the patient was supplied with O₂ 5L/min. and assisted respiration. We found, while observing the patient’s condition, that blood pressure dropped to 95–80 one hour after operation. With the aid of carriegen 1/2 ampoule, blood pressure stood at 120–80, and pulse at 70. At 7:35 the patient regained his perfect consciousness with blood pressure 135–95 mmHg, respiration at 30/min. and pulse at 80/min. and was extubated. Remarks during anaesthesia and operation: Blood loss 425g, blood transfusion, fresh blood 400 ml, stored blood 200 ml, 5% glucose 650 ml, Dextran 500 ml, VB, 100 mg, VC 100 mg, Tiocartan 2 ampoules, Bislase 1 ampoule. Alaminin F 50, 40 ml.

<table>
<thead>
<tr>
<th>a) Comparison between the Preoperative and Postoperative Results of Tests</th>
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</thead>
<tbody>
<tr>
<td><strong>Preoperation</strong></td>
</tr>
<tr>
<td>BP</td>
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<tr>
<td>Blood chemistry</td>
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<tr>
<td>NPN</td>
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<tr>
<td>Na</td>
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<tr>
<td>K</td>
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<tr>
<td>Cl</td>
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<td>Ca</td>
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<td>Mg</td>
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<td>pH</td>
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<td>Urinalysis</td>
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<tr>
<td>Volume</td>
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<tr>
<td>sp. G.</td>
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<tr>
<td>pH</td>
</tr>
<tr>
<td>Na</td>
</tr>
<tr>
<td>K</td>
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<tr>
<td>Renal function</td>
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<tr>
<td>PSP test 15'</td>
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<tr>
<td>70'</td>
</tr>
<tr>
<td>Creatinine clearance</td>
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<tr>
<td>Function test of the endocrine</td>
</tr>
<tr>
<td>Urinary aldosterone</td>
</tr>
<tr>
<td>Urinary 17KS</td>
</tr>
<tr>
<td>Urinary 17OHCS</td>
</tr>
</tbody>
</table>
fatigue, diminution of the urine volume, elevation of specific gravity of urine, increases of serum potassium and magnesium, and decrease of urinary aldosterone.

b) Pathology (Fig. 6, 7, 8, 9, 10, 11)

Nephrosclerosis probably following tuberculosis and adenoid hyperplasia of right adrenal gland.

The removed kidney weighed 90 gm. and on its surface irregularly scattered deep depressed areas were recognized. In the stem of the renal artery there was no sclerotic change. Histologically in almost all glomeruli were found the fibrous thickening of mesangium, hyalinization, narrowing of the capillary lumina and fibrous thickening of Bowman’s capsules, even some of which were entirely hyalinized. In the interstice the increase of the fiber was seen diffusely. The depressed parts were cicatrized, resulting in dilapidation of the parenchyma with prominent atrophy of the cortex. In most parts of the medium-sized and small arteries the sclerotic changes such as some irregular fibrous thickening and increase of the elastic fiber of the intima narrowed the vascular lumina. Some parts of the arteries showed complete obstruction. And occasionally those vessels with such a thickening of the intima seemed to be accompanied by the lesion of the media. Furthermore, in some depressed scarred areas were seen the productive tuberculous foci with partial calcification. This might be what Hans Wildbolz[10] calls a “fibro-indurative form”. In the interstice and the pelvis marked lymphocytic infiltration was noted.

As pointed above, the findings in the kidney were quite complicated. However as for sclerotic changes and cicatrization in glomeruli and interstice, they were understood to be ischemic changes caused by arterial narrowing or obstruction. Vascular changes, with the lesions seen both in the intima and in the media, were thought to be vascular fibrosis resulted from vasculitis. Namely the kidney shows evidence of ischemic changes and productive tuberculosis. The former, we understood, caused high blood pressure. The adrenal weighed 10 gm. and the width of the whole cortex was almost normal, but in the zona glomerulosa and the outer parts of zona fasciculata adenoid hyperplasia of clear cell was recognized. And outside the fibrous capsule three milliary adenomans were formed, which were composed of the clear cells, too.

V. COMMENT

1) Definition of Secodary Aldosteronism

Conn (1956)[4] gave the name of aldosteronism to the syndrome characterized by the symptoms such as hypertension, paralysis, polyuria, tetany, hypokalemia and hypersecretion of aldosterone. He distinguished two different categories out of this syndrome. and named them primary and secondary aldosteronisms.

Primary aldosteronism is the syndrome characterized by the hypersecretion of aldosterone that is caused by adrenal cortical tumor (adenoma or hyperplasia). The symptom will be improved by removal of adrenal tumor and hyperplasia. Secondary aldosteronism is caused by hypersecretory disorder of the adrenal cortex through some irritation that comes from somewhere other than the adrenal. It usually lacks the aldosterone-secreting tumor. In some of the reported cases of...
secondary aldosteronism could be recognized either nodular hyperplasia or the normal gland histologically.

Some of the causes of secondary aldosteronism include potassium losing kidney diseases that occur along with an edematous condition through nephrosis, cirrhosis of the liver, and heart failure, certain hypertensions (malignant hypertension and renovascular hypertension), and villous adenoma of the rectum.$^{84}$

Following is the table of hyperaldosteronism by Laragh (1964)$^{110}$:

<table>
<thead>
<tr>
<th>Primary hyperaldosteronism (adrenal in origin)</th>
<th>Conn's Syndrome due to adrenal adenoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Oedematous states</td>
<td>1. Cirrhosis</td>
</tr>
<tr>
<td>1. Nephrasis</td>
<td>2. Heart failure</td>
</tr>
<tr>
<td>3. Malignant hypertension</td>
<td></td>
</tr>
<tr>
<td>B. Hypertensive states</td>
<td>1. Malignant or severe hypertension due to unilateral renal disease</td>
</tr>
<tr>
<td>2. Chronic hypertension</td>
<td>C. Alkalotic (normotensive) states potassium wastage</td>
</tr>
<tr>
<td>C. Alkalotic (normotensive) states potassium wastage</td>
<td>Alkalosis retarded growth</td>
</tr>
<tr>
<td></td>
<td>* Bartter syndrome</td>
</tr>
</tbody>
</table>

Bartter et al. (1962)$^{52-54}$ differentiated their syndrome—found in three Negro cases—from Conn's syndrome. The syndrome, like the case of primary aldosteronism, had hypersecretion of aldosterone and other symptoms of hypokalaemic alkalosis, tetany, inability of the adequate urine concentration with increased concentration of angiotensin in the blood, the manifestation of hypertrophy of juxtaglomerular apparatus, and hyperplasia of the adrenal.

As for the cause of this, Bartter et al., observing the fact that the blood pressure had allow reaction to angiotensin II, held that this syndrome was caused by a hypersecretion of aldosterone by means of Renin-Angiotensin system, following hyperplasia of juxtaglomerular apparatus through the congenital low sensitivity to angiotensin.

A case of hyperplasia of adrenal cortex without the symptom of adenoma was first reported in a 17-year-old boy who had a malignant hypertension by Buchem et al. (1956)$^{111}$ More cases of the same sort have reported since then.$^{112-118}$

Conn (1961)$^{51}$ named the case of hyperaldosteronism in a youth either without the tumor or with the bilateral adrenal hyperplasia in the adrenal cortex as "primary aldosteronism without adenoma" then later in 1964$^{51}$ he gave the term of congenital aldosteronism to the case, for he held that the cause of this was due to an abnormal function of the renal juxtaglomerular apparatus, and put it in the category of secondary aldosteronism.

We cannot overlook the fact that Conn had his view about this case changing after his first report.

2) Diagnosis of Primary Aldosteronism:

Conn (1964)$^{51}$ pointed out that the four main symptoms of primay aldosteronism were degeneracy of muscular power, polyuria (specially nocturnal polyuria), headache, and thirst, and as for other minor symptoms, he pointed out that there were abnormal sensation, visual distur-
bance, intermittent paralysis, tetany, and fatigue. Onsets of paraesthesias, intermittent paralysis, and tetany do not occur in the case of males as often as in the case of females. Hypertension is general in all cases, most of which are of benign nature, and in about half of which mild retinopathy is manifest.

As for the frequency of primary aldosteronism according to sex, it occurs rather frequently in females (male: female 1:26), while according to age groups, 72% of the whole cases are occupied by the groups between their thirties through fifties. Solitary adenoma is 91% and multiple adenoma is 9%. Adenomas of less than 6 gm. 68%, those with the diameter of less than 3 cm 73% and more common left than right side 73:37 (almost 6:3).

As the result of the renal function test of 113 cases with primary aldosteronism we see the decreased concentrating ability (80%), albuminuria (85%), no response to pitressin (80%), while more than 60%

Clinical Findings of Primary Aldosteronism (Tumor) by J. W. Conn et al., (1964)

I. Renal
   *1. Polydipsia
   *2. Polyuria
   *3. Nocturia

II. Muscular
   *1. Weakness, usually episodic
   2. Flaccid paralysis, occasional
   3. Occasional tetany
   4. Manifest or latent paraesthesias

III. Hypertensive
   *1. B.P. elevation—mild to very severe
      (270/160)
   *2. Headache—major symptom
   3. Retinopathy—minimal in relation to B.P.
      elevation
   4. Cardiomegaly—minimal in relation to B.P.
      elevation

IV. Important Negatives
   1. Peripheral oedema—absent or minimal
   2. Grade IV retinopathy—absent

IV. ECG—Changes compatible with hypokalemia
   *---most common

3) Differential Diagnosis of Primary Aldosteronism and Secondary Aldosteronism

Differential diagnosis has been discussed
Some Clinical Implications of Aldosteronism

<table>
<thead>
<tr>
<th></th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationship of hypertension</td>
<td>(benign) mild</td>
<td>(malignant) not invariably severe</td>
</tr>
<tr>
<td>Retinopathy</td>
<td>Grade IV absent</td>
<td>papilloedema (75%)</td>
</tr>
<tr>
<td>Albumuria</td>
<td>little</td>
<td>much</td>
</tr>
<tr>
<td>Peripheral oedema</td>
<td>none</td>
<td>present (lacking rarely)</td>
</tr>
<tr>
<td>Urinary Aldosterone</td>
<td>increased</td>
<td>increased</td>
</tr>
<tr>
<td>Serum electrolytes</td>
<td>hypokalaemia</td>
<td>hypokaemia</td>
</tr>
<tr>
<td>potassium level</td>
<td>hypernatraemia</td>
<td>usually normal, occasionally low</td>
</tr>
<tr>
<td>sodium level</td>
<td>increased</td>
<td>decreased</td>
</tr>
<tr>
<td>Total blood volume</td>
<td>abnormal</td>
<td>normal</td>
</tr>
<tr>
<td>Circulatory reflexes</td>
<td>response to &lt;4m(\mu)g/min.&gt;</td>
<td>response to &lt;6.5m(\mu)g/min.</td>
</tr>
<tr>
<td>Angiotensin infusion test</td>
<td>low (renin) level</td>
<td>high (renin) level</td>
</tr>
<tr>
<td>Plasma renin activity</td>
<td>no difference</td>
<td>involved on the affected side</td>
</tr>
<tr>
<td>Divided renal function</td>
<td>normal</td>
<td>unilateral constriction of the renal artery</td>
</tr>
<tr>
<td>Renal aortography</td>
<td>adrenal tumor present</td>
<td>adrenal tumor none</td>
</tr>
<tr>
<td>PRP, Nephrotomography</td>
<td>curable</td>
<td>ineffectual</td>
</tr>
<tr>
<td>Adrenalectomy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

by the scholars from biochemical, functional and roentgenographical views. The following is a table that shows the outline of differential diagnosis of aldosteronism discussed by them.

Until recently it has been held that primary aldosteronism always signifies hypokalaemia. However Conn et al. recently (1965) reported a case of hypertension with increased aldosterone and low plasma renin activity despite of the normal value of conserve serum potassium, and named it “Normokalemic Primary Aldosteronism”.

He continued to explain that the hypertension of this case can be improved by removing the adrenal in which the small adenoma develops.

Moreover Conn et al. (1966) added six more cases of normokalemic primary aldosteronism. He suggested that the cases diagnosed as essential hypertension may conceal a good many small aldosterone-producing adenomas and that the most effective method of this diagnosis is to see hypersecretion of aldosterone in the urine and the suppression of plasma renin activity. He again suggested that primary aldosteronism characteristically inhibits the function of renin-angiotensin.

4) Histological Examination of Adrenal Cortex and Observed Hyperaldosteronism.

Hyperplasia of adrenal cortex can be observed commonly at autopsy in the adult males that while alive did not show any clinical incretional disturbances, and its frequency is remarkably high in the males of 60 or older. Russi et al. (1945) reported adrenal cortical adenoma in 1.45% of 9,000 autopsies and recognized two different sizes of adenoma, big and small. The big kind—Cushing’s syndrome or adrenogenital syndrome mainly—is incretionally active, and the small kind, 10 mm in diameter, is inactive incretionally, and this latter small adenoma can hardly be differentiated from aldosterone-producing adenoma.

Wilens and Plair (1962) at New York Veterans Administration Hospital observed 1,000 autopsies from 1958 through 1961, and out of 993 they found 114 cases of bilateral cortical hyperplasia (11.5%), 35.1% of which were found to be of hyperten-
<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>B.P.</th>
<th>Funduscopy</th>
<th>Albuminuria</th>
<th>Urinary Aldosterone</th>
<th>Pathological findings</th>
<th>Course</th>
<th>Clinical observation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Renal artery</td>
<td>Kidney</td>
<td>Adrenal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>r. Renal ischemia, glomerular crowding, tubular atrophy. Hypertensive changes in l. Kidney.</td>
<td>Adrenal 5.2g, no tumor</td>
<td>Nephrectomy (r.) subtotal adrenalectomy. After operation symptoms had losted, BP returned to normal.</td>
</tr>
<tr>
<td>54</td>
<td>M</td>
<td>Hypertension</td>
<td>K-W III</td>
<td>Raised</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>38</td>
<td>M</td>
<td>240/140</td>
<td>Papilledema</td>
<td>over 1g/L</td>
<td>1.5 cat units per 10 ml of plasma</td>
<td>Aortograms demonstrated an abnormal r. renal artery.</td>
<td>IP: Both poor concentration. RP: (r) Kidney slight distortion of the r. lower calyx r. Kidney 127g. (Infarction)</td>
<td>After Nephrectomy all the signs was improved.</td>
</tr>
<tr>
<td>56</td>
<td>M</td>
<td>270/120</td>
<td>Papilledema</td>
<td>22g/day</td>
<td>1.5 cat units per 10 ml of plasma</td>
<td>The arteries of the kidneys were shrunken. Internal elastic lamina reduplicated. Intimal fibrous endarteritis.</td>
<td>IP: r. Kidney poor concentration nephrogram: r. Kidney reduced clearance r. Kidney 115g. 11×8×5.5 glomeruli normal tubules were mostly shrunken and separated by fibrous tissue.</td>
<td>r. Nephrectomy. Post-operative course: BP 190/90. Retinitis recovered. Serum potassium concentration normal.</td>
</tr>
<tr>
<td>Name</td>
<td>Age</td>
<td>SBP/DBP</td>
<td>BP</td>
<td>Protein</td>
<td>Creatinine</td>
<td>Adrenals</td>
<td>Ad. surgery</td>
<td>Recovery</td>
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<tr>
<td>Laidlaw et al.</td>
<td>55</td>
<td>190/140, 170/90</td>
<td>(-)</td>
<td>19 µg/day</td>
<td>1. renal artery occluded with a thrombus</td>
<td>r. kidney 265g. l. kidney 125g. r. kidney was potassium depletion nephropathy. l. kidney was atrophy, infarction of the l. kidney.</td>
<td>r. adrenal 11g. l. adrenal 10g. A small cortical adenoma, nodular hyperplasia.</td>
<td>Bilateral adrenalectomy. Dead eight hours after operation.</td>
</tr>
<tr>
<td>Détrot et al.</td>
<td>33</td>
<td>180/120</td>
<td>(-)</td>
<td>6.8 µg/day</td>
<td>Translumbar aortography: aneurysma of r. renal artery. Nephrogram: r. kidney showed marked contraction of r. kidney. r. kidney: large infarct in the lower pole. Ischemic atrophy of tubules and glomeruli.</td>
<td>Post nephrectomy (r) BP: 116/70 Papilledema regression.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fukuchi et al.</td>
<td>46</td>
<td>200/90, 210/140</td>
<td>10g/dl</td>
<td>70 µg/day</td>
<td>IP and retrograde pyelogram with left contracted kidney.</td>
<td>r. kidney: nephrosclerosis, nephropathy complex. (pyelonephritis with thrombosis of l. renal artery)</td>
<td>l. nephrectomy Hypertension cured. Plasma electrolytes normal.</td>
<td></td>
</tr>
<tr>
<td>Wrong</td>
<td>39</td>
<td>Hypertension</td>
<td>12.0-43.7 µg/day</td>
<td>Pyelogram: r. kidney hypoplasia. Figure of essential hypertension.</td>
<td>No adrenal tumor but hyperplasia.</td>
<td>Probe laparatomy. Hypertension cured. Anxiety disappeared.</td>
<td></td>
<td>Haematuria, anxiety, insomnia.</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>F 230/90</td>
<td>KW IV</td>
<td>Not measured</td>
<td>Aortic aneurysma involving both renal arteries</td>
<td>Adrenals infarcted as result of surgery, but no tumour.</td>
<td>Excision of aneurysm and replacement by graft. Died after aortic resection.</td>
<td>Nocturia, plasma potassium 3.3m Eq/L, plasma total CO₂ 31.2m M/L.</td>
</tr>
<tr>
<td>No.</td>
<td>Age</td>
<td>Gender</td>
<td>BP (mmHg)</td>
<td>Stage</td>
<td>Condition</td>
<td>Left Kidney</td>
<td>Right Kidney</td>
<td>Test</td>
</tr>
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</tr>
<tr>
<td>53</td>
<td>M</td>
<td>230/140</td>
<td>225/135</td>
<td>IV</td>
<td>Moderate proteinuria</td>
<td>Not measured</td>
<td>Not measured</td>
<td>Aortogram: narrowing of r. renal artery</td>
</tr>
<tr>
<td>25</td>
<td>F</td>
<td>200/140</td>
<td>Papilledema</td>
<td>3g/L</td>
<td>Aldosterone rose during administration of potassium</td>
<td>Not measured</td>
<td>Not measured</td>
<td>Aortogram: constriction of r. renal artery</td>
</tr>
<tr>
<td>42</td>
<td>M</td>
<td>230/150</td>
<td>KW II</td>
<td></td>
<td>Excretion rate in normal range. Secretion rate raised.</td>
<td>11.4 μg/day</td>
<td>Not measured</td>
<td>Aortogram: bilateral double renal arteries. Stenosis on l. inferior, with shrunken lower pole of l. kidney.</td>
</tr>
</tbody>
</table>

**Wrong et al. (1962)**

**Hökfelt (1962)**
<p>| Sambhi et al. (1963) | 44 | F | 200/110 | | 17 μg/day (secretion rate) | Aortogram: stricture of r. renal artery. Lumen of r. renal artery reduced to 2 or 3 mm at its origin at the aorta. | Pyelogram: small r. kidner. | Aorto-renal graft, postoperative BP returned to normal. | Duration of hypertension 5yr. with marked progression over past 2yr. |
| | 49 | M | 260/140 | | 245 μg/day (secretion rate) | Aortogram: complete obstruction of I. renal artery. | Pyelogram: small I. kidney. I. renal capsula was adherent over an irregular depressed in the lower pole; cortex in this area was dark red and finely granular. | L. nephrectomy. Post operative BP improved. | Duration of hypertension 2yr, hypokalemia. |
| Schwab et al. (1963) | 55 | M | 240/135 | Retinitis angiospatica | 1.5-1.2 g/l. 120 μg/day 7.5 μg/day | Aortogram: stricture of I. renal artery. I. renal artery showed occlusion of atheromatous organized thrombosis. | Pyelogram: small I. kidney. 9 × 6 × 5 cm, atrophy of tubuli, sclerosis of glomeruli, interstitial fibrosis, &amp; fibrosis of Bowman’s capsule. | L. nephrectomy. After operation clinical signs corrected. | Headache, dysbasia, polyuria, polydipsia, tetany, thirst, hypokalemia. |</p>
<table>
<thead>
<tr>
<th>Name et al. (1963)</th>
<th>Age</th>
<th>Sex</th>
<th>BP</th>
<th>Tension</th>
<th>Stage</th>
<th>Proteinuria</th>
<th>Estimation</th>
<th>PRP</th>
<th>Autopsy</th>
<th>Headache</th>
<th>Nocturia</th>
<th>Paralysis of limbs, hypokalemic alkalosis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldberg et al. (1963)</td>
<td>62</td>
<td>F</td>
<td>230/120 75/100</td>
<td>(KW II)</td>
<td>(mg)</td>
<td>40 μg/day 2.5 μg/day</td>
<td>Aortogram: stenosis of r. renal artery at its origin. r. renal artery occluded the lumen.</td>
<td></td>
<td></td>
<td>1. Nephrectomy and patch-graft under hypothermia, all clinical signs disappeared after operation.</td>
<td></td>
<td></td>
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<tr>
<td>Blagg et al. (1964)</td>
<td>49</td>
<td>F</td>
<td>190/140</td>
<td>(Retinopathy IV)</td>
<td>(+)</td>
<td>Not measured</td>
<td>Aortogram: l. renal artery narrowed. r. renal artery showed degenerative arterial disease.</td>
<td></td>
<td>IP: poor concentration and small r. kidney.</td>
<td>Headaches, dizziness, polydipsia, polyuria, nocturia, weakness, thirst, hypokalemia.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smithwick et al. (1964)</td>
<td>52</td>
<td>F</td>
<td>170/110</td>
<td>(Retinitis with hemorrhages and exsudate)</td>
<td>Not measured</td>
<td>Aortogram: obstruction of r. renal artery. r. renal artery was obstructed by an arteriosclerotic plaque.</td>
<td></td>
<td>IP, Renogram: r. kidney no function, r. kidney 64g, chronic pyelonephritis, ischemic tubular atrophy.</td>
<td>Nephrectomy (r.) Serum electrolyte, BP returned to normal fourteen mouth after operation.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Schröder et al. (1965)</td>
<td>54</td>
<td>M</td>
<td>190/110</td>
<td>Small hemorrhage and Gunn's phenomenon.</td>
<td>1.8–14.5 g/L</td>
<td>30–100 µg/day</td>
<td>Aortogram: Stenosis of 1. renal artery, thrombosis of 1. renal artery.</td>
<td>IP: small 1. kidney, 1. kidney 85g, atrophy of 1. kidney.</td>
<td>I. nephrectomy. After operation all clinical signs disappeared.</td>
<td>Headaches, fatigue, loss of weight, polyuria, dysbasia, hypokalemia, divided renal function tests showed difference, hypokalemic ECG.</td>
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</tr>
<tr>
<td></td>
<td>63</td>
<td>M</td>
<td>230/130</td>
<td>Papilledema.</td>
<td>2.0–10.0 g/L</td>
<td>42 µg/day</td>
<td>Aortogram: r renal artery completely occluded. Arteriosclerosis of renal artery.</td>
<td>IP: small r. kidney atrophy of tubulus, glomeruli normal.</td>
<td>r. nephrectomy. BP, plasma electrolytes returned to normal.</td>
<td>Headaches, fatigue, loss of weight, polyuria, dizziness, hypokalemic ECG.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suzuki, Sasaki (1966)</td>
<td>38</td>
<td>M</td>
<td>160/100</td>
<td>KW I (±)</td>
<td>20.7 µg/day</td>
<td>8.6 g/day</td>
<td>Aortograms no abnormal findings.</td>
<td>r. renal tuberculosis (fibro-indurative form)</td>
<td>r. Adrenal lgm hyperplasia.</td>
<td>r. nephrectomy, total r. Adrenalectomy After operation BP returned to normal.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Schröder et al. (1965) was the first to introduce the concept of adrenal hyperplasia as a cause of hypertension. It has recently been made clear that what controls the secretion of aldosterone is renin-angiotensin system. That is, wall of arteries, not like other cortical hormones, is not widely controlled by ACTH. It has not been made clear that what controls the secretion of aldosterone is renin-angiotensin system.
glomerular afferentia works as a stretch receptor, whose relaxation will induce renin from juxtaglomerular cells, and whose strain will inhibit the secretion.

Renin will act on a substrate in blood plasma that belongs to α-globulin demarcation, giving rise to Angiotensin I which is decapeptide, which in turn will be transformed into Angiotensin II through the converting enzyme in blood plasma. It is said that Angiotensin II, being octapeptide, will perform boosting to vascular tension on one hand, and will stimulate secretion of aldosterone when it acts on the adrenal on the other hand.

Renal ischemia, through the agent of renin, will be the cause of hypertension. But renin is a strong stimulant as to aldosterone secretion. So here comes up a clear chain relation such as renal ischemia → increased renin secretion → hyperaldosteronism. Thus secondary aldosteronism by renal ischemia became a well defined clinical entity. So far 30 cases have been reported. You can see the outline of the cases in Table 1.

Fitz et al. (1963) reported some rare cases of primary aldosteronism that involves renal artery stenosis. In the case reports that we gathered from the literatures we acknowledged four cases of complication of adrenal cortical hyperplasia with renal artery stenosis.

Wrong (1964) on this point says, “Either a patient with long-standing primary aldosteronism might develop renal ischemia because of the damaging effect of hypertension on the renal vascular, or renal artery stenosis might lead to the formation of an adrenal adenoma through the effect of long continued stimulation by the renin-angiotensin mechanism. At present it is not possible to choose between these alternatives” But he admits the theory of adrenal adenoma formation by renovascular stenosis speculatively.

6) Trends of Hyperaldosteronism and Hypertension

When Carey L. C. and Ellison E. H. (1961) reported “primary aldosteronism and hypertension related to it” at the 68th Annual Meeting of the Western Surgical Association in December, 1960. Williams. R. (Columbus, Ohio) made two questions, saying, “First, how commonly is this disease a cause of hypertension, that is, in relation to other known causes? Second, since about 20% of the reported cases show recurrence of hypertension after surgery, I wonder why the authors feel that this is most likely due to failure to remove all tumor or hyperplastic adrenal tissue, rather than to renal arteriolar damage”

Here is Carey’s answer to the second question, which interests us here in particular.

“In answer to Dr. Williams’ second question, the hypertension of this disease recurs in about 20% of the cases. Other authors have suggested that the recurrence is due to severe renal damage. We have been unable to correlate either the severity or the duration of the patients’ hypertension to the likelihood that he will have recurrence.

We feel that perhaps the recurrence is not due to renal damage, because the patients have most often an initial drop in blood pressure and then a return to hypertensive levels. It seems a very good possibility that a small adenoma is overlooked initially in these patients”.

Reading Laragh (1964) that was mentioned before, the theory of Bartter
syndrome (1962) in secondary aldosteronism or the definition of aldosteronism and especially that of congenital aldosteronism as for hypertension by Conn (1961), we understand that we cannot accept these matters easily without some necessary proofs.

VI. SUMMARY

As for our personal case, we placed it tentatively in the category of secondary aldosteronism, but we could acknowledge only four cases of cortical hyperplasia (of which our case is the fourth) in all 30 cases that we could gather from the literatures. We rather hesitate as to whether we should place it in the primary kind in a broad sense or in the secondary proper. Not only that, judging from all such complexity as the view of Wrong (1964) that was mentioned a while ago, Sasano's pathological view (1965), Conn's view (1965) that 20% of essential hypertension cases have primary adrenal tumors, and Nesbit's proof (1966) of cortical hyperplasia on the excised adrenal from the hypertensive patient, we have come to see a trend recently that the matter of aldosteronism is beginning to play its delicate role not only in the problem of classification of the primary and the secondary of aldosteronisms but also in the diagnosis of essential hypertension.

VII. CONCLUSION

We diagnosed the case of a 38-year-old man before operation, whose main complaints were fatigue, headache, polydipsia, hyposthenuria, and hypertension, as primary aldosteronism originating from the right adrenal, as examined with PRP combined nephrotomography, judging from his value of serum potassium at the low in the normal limit, the increased aldosterone in the urine, no arteriolar narrowings on both sides as proved by renovasculography.

We attempted adrenalectomy on the patient through thoraco-lumbar approach under the hypothermic anaesthesia method, but with the intensive adhesion around the upper pole of the right kidney and the renal surface we were compelled to perform the total adrenalectomy and nephrectomy. We found that the case was histologically nephrosclerosis caused by fibrotic indurative typed renal tuberculosis concomitant with adrenal cortical hyperplasia. Moreover, we have added some review of the literatures concerning secondary aldosteronism caused by renal ischaemia, and referred to remaining problems of aldosteronism and hypertension up to date.

Before we conclude our report, we desire to express our deep appreciation of the assistance rendered us by Assistant Professor Hokano (Department of Pathology) and Professor Miyake (Department of Anaesthesiology). We also desire to express our thanks to the cooperations of Dr. Yamada (Director: Prof. YOSHITOSHI for the measurements of catecholamine, and Dr. Oda (Director: Prof. OSHIMA) for the measurements of aldosterone excretion.

VIII. REFERENCES

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S. SUZUKI & H. SASAKI: SOME REMAINING PROBLEMS OF ALDOSTERONISM


S. SUZUKI & H. SASAKI: SOME REMAINING PROBLEMS OF ALDOSTERONISM

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122) Itskovitz, H. D., Hildreth, E. A., Sellers, A. M., and Blakemore, W. S.: The granu-


自症例による Aldosterone 症の 2, 3 の問題
東京医科大学泌尿器科学教室（主任：鈴木 三郎教授）
鈴木 三郎
佐々木 寿

症例は両側副腎摘核の既往歴があり、2年前から多飲、疲労感、頭痛、高血圧160〜100 mmHgを主訴とした38才の男子である。血液化学所見としては、K 3.8 mEq/L, Na 139 mEq/L, Mg 2.25 mEq/L で尿中 17KS, 17OHCs, catecholamine は正常範囲であったが尿中 aldosterone 量は 20.7μg/day, RISA による Plasma volume は 56.9 ml/kg, Metopirone, Spironolactone test は陽性、腎機能は軽度の障害があり、眼底所見は KWI, Angiotensin infusion test は15.7 milimicrometer per Kg per minute で血圧 (diastole) 20mmHg 上昇をみた。Aortography では腎動脈に狭ががなく、PRP, Tomography の併用により右側腎高血圧による "Primary Aldosteronism" と診断した。

低体温麻醉の下に Thoraco-abdominal incision で Adrenalectomy を試みたが、右副腎と右腎との維着が強く、止むなく右副腎摘出と右腎摘出を施行した。術後1ケ月には臨床症候の改善をみた。

組織学的には腎結核一線維硬化型と副腎の線維増殖が認められた。
Simultaneous retroperitoneal pneumogram and tomogram.

Fig. 3. Excretory urogram.

Fig. 4. Segmental aortogram.

Fig. 5. Simultaneous retroperitoneal pneumogram and tomogram.

Fig. 6. The artery wall shows marked thickening and almost obliterate its lumen. And find a conglomerate tubercle in contact with its wall. ×4.

Fig. 7. The interlobular arteriole showing the thickening with almost complete obliteration of the lumen and marked fibrosis at the periarterial area. While others show many dilated tubules filled with colloid casts and abundant lymphocytes permeate in the interstitial tissue. ×10.
Fig. 8. The arterioles reveal its thickening. ×20.

Fig. 10. Adenomatous nodule of the adrenal cortex. ×20.

Fig. 9. Photomicrograph showing hyalinized glomerulus, resemblance to as in Fig. 7. ×20.

Fig. 11. The cortex shows the hypertrophy at the outer zone of zone fasciculata. ×20.