PREVENTION IN HYPERTENSION

By Hideo Ueda

In many countries, particularly in Asian area, hypertension and cerebral stroke are the most frequent form of cardiovascular disease and moreover the chief cause of death. The prevention and control of hypertension are very important for the health and welfare of mankind.

Prevention in hypertension has three directions to approach, one is the prevention of fatal complications related to hypertension in hypertensive patients, such as stroke, myocardial infarction, congestive heart failure and renal failure. The second direction is the prevention of death and inabilities due to hypertension by screening and control of hypertension in the community. The third is broad epidemiological prevention of hypertension by reducing the risk factors. This paper deals with some results of my studies in three directions of prevention in hypertension.

1. The effect of long-term antihypertensive treatment to prevent the complications of hypertension.

The modern antihypertensive treatment since 1950 is most potent to reduce the incidence of severe complications and mortality of hypertension (Smirk 1965, de Freis 1971).[1]

The long-term control of hypertension in my study (Ueda 1964)[2] shows remarkable reduction of stroke and next cardiac and renal death. However, the antihypertensive treatment is effective to prolong the life, only when the treatment is adequately performed. The results of discontinued therapy is worse than the untreated group and bad-controlled group.

In the followup study of seven years, the survival rate in the treated mild hypertension is about 94% (KW I 95%, KW II 93%) and in treated advanced hypertension is over 74% (KW III 77%, KW IV 67%), whereas, in untreated mild hypertension is 80% and in advanced cases the survival rate is 60% (KW I 91%, KW II 76%, KW III 66%, KW IV 0% in five years).

2. Screening and control of hypertension.

(a) Preventive effect of medication to complications for detected mild hypertension.

Prophilactic use of 0.1 mg of reserpine and 12.5 mg of hydroflumethiazide daily for three months in winter resulted in significant fall of blood pressure and prevention of stroke until one year after the medication in 426 subjects, while three cases of stroke appeared in placebo group of 408.[3]

(b) Systematic control programme for hypertension.

The systematic control programme has been undergone in JNR for eleven years. The main projects are as follows: detection of unconscious hypertensives by periodical mass screening, care of the detected cases by guidance, check and advice of necessary treatment and prevention of complications, particularly the stroke.

The result of control programme in JNR Tokyo area since eleven years ago is summarized in Fig. I. The prevalence of hypertension (150/90 or more) decreased from 30.6% to 23.5% in 1963 and since then recovered the initial level. Nevertheless, the advanced hypertensives over 180/110 came down rapidly from 7.0% to 3.4%. The stroke mortality lowered to one third of the initial level (from 90 to 28 per 100,000). The mortality of IHD is low and seems not to be effected by the control programme.

There have been many discussions on the necessity and length of antihypertensive drug treatment for mild hypertension. However, the medication seems in favour to prevent aggravation and accident of hypertension.

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3. Prevention of hypertension by reducing the risk factors. (The effect of diet on hypertension).

Most important approach to prevent the hypertension in each community and country is the mapping and reducing of risk factors in hypertension. Among the risk factors (heredity, environment, salt, obesity, stress, cold climate and poor heating, overwork), the salt and diet, factors may play important roles in the etiology of hypertension.

The prevalence of hypertension in north Japan is very high, where people take great amounts of rice diet with high salt. Besides salt and carbohydrate, the diet contains only low protein. It is generally accepted that experimental hypertension can be induced in animals by continuous high salt intake.[4]

However, in respect of the kind of food, their roles as the cause of hypertension are not yet clear. This paper shows briefly the results of my study on the effects of salt and diet on the blood pressure, eyeground, biochemistry and autopsy findings of Goldblatt rat and Spontaneously Hypertensive Rat (SHR).

(a) Effects of diet on the blood pressure of Goldblatt rat.

Methods and materials: Female rats of the Dawley strain weighing 90 to 100 g were used. Blood pressure was measured by the microphonic cuff method every two weeks. The Goldblatt rats were induced by the constriction of left renal artery with silver clip and the right nephrectomy one week later. After five weeks from operation, various kinds of food by the combination of salt, protein, fat and carbohydrate.[5]

Results: The changes of blood pressure nine weeks after experimental diets are as follows:

C	Goldblatt rat of control diet	144 to 152 mmHg	(+6%)
S_1	high salt, high fat	158 to 187	(+18%)
S_2	high salt, high protein	147 to 170	(+L6%)
S_3	high salt, high carbohydrate, low protein	147 to 194	(+32%)
S_4	high salt	151 to 157	(+4%)

Heart weight and high blood pressure of each dietary group have good relationship. Heart weight index was calculated (heart weight/body weight X 1000).

C	blood pressure 152,	heart weight index 3.2
S_1	187,	5.1
S_2	170,	4.9
S_3	194,	5.6

Summary: high salt, high carbohydrate and low protein diet causes significant elevation in blood pressure of renal hypertensive rats, comparing with the other experimental diet. The normal control rats did not show increase in blood pressure by the similar diet after nine weeks. (Fig. 2).

(b) Effects of high salt, high carbohydrate and low protein diet on the blood pressure of SHR.[6]

Methods and materials: Fourty eight female SHR in generation of F_{24} were used with twelve Wister rats as control. The systolic blood pressure was measured by the tail-water plethysmographic method from the 5th week after birth. The 48 SHR were divided in four groups, each of them was given different experimental diet. One percent salt solution was given to the high salt SHR groups.

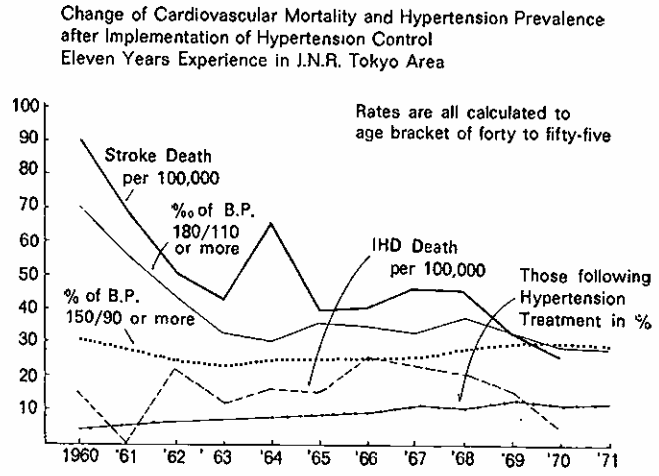

Fig. 1.

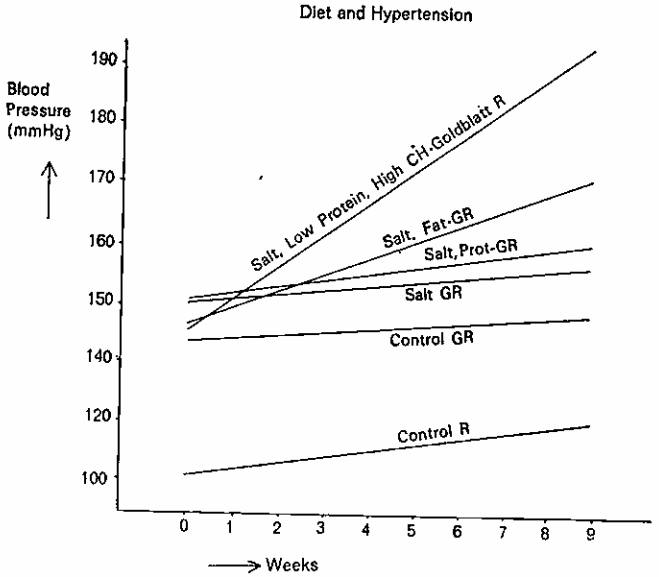

Fig. 2.

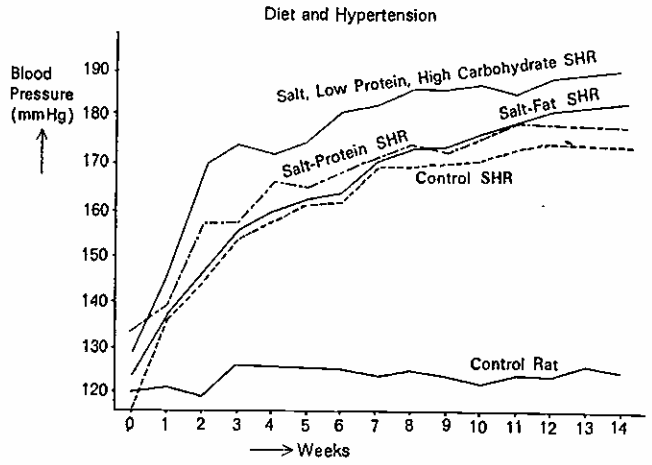

Fig. 3.

The control Wister rats(C_1) and one SHR group (C_2) were given common diet (protein 21%, fat 16%, carbohydrate 56%). The other three SHR groups were given the following diets: high salt and high fat diet to S_1 group (protein 12%, fat 58%, carbohydrate 16%), high salt and high protein diet to S_2 group (protein 64, fat 4, carbohydrate 14%), high salt, high carbohydrate, low protein diet to S_3 group (protein 5, fat 5, carbohydrate 82%).

In the beginning of 6 weeks after birth, the special diets were given and then the blood pressure was measured every week. At the end of ten weeks, half of each group were sacrificed and the blood was sampled for biomedical analysis and the weight of each organ was measured and main organs were offered for pathological examination. After 14 weeks, three rats of each group were sacrificed for the same examination.

RESULTS

The blood pressure of high salt, high carbohydrate and low protein group S_3 is the highest and the control SHR shows the lowest among SHR group during the 14 weeks (Fig. 3).

The body weight of normal diet SHR and S_2 are larger and nextly the control Wister rat and S_1 group follow. The low protein SHR (S_3) shows lower value in body weight in the early stage and it reaches almost the level of high fat group.

The fundi of ShHR with normal diet shows in 17 weeks age narrowing and tortuosity in retinal arterioles.[7] The eyeground of high fat and high salt SHR shows marked narrowing and caliber irregularity. The high protein SHR reveals broader caliber of retinal arterioles than that of S_1 and S_3 SHR. The SHR with high salt, high carbohydrate and low protein shows the narrowing and irregularity of arteriole wall and moreover, capillary dilatation and proliferation of chorioidal arterioles. Therefor, the hypertensive changes of retinal arterioles are remarkable in S_1 and S_3, moderate in S_2 and control SHR group.

URINE

The daily urinary volume increased in high salt group ($S_{1\text{-}2\text{-}3}$) and albuminuria was noticed in S_2.

BLOOD

Potassium was 3.8 meq/l in S_3, 5.3 in S_1 and 4.1-4.3 in $C_{1\text{-}2}$ and S_2. Total protein and BUN are clearly low in low protein and high salt SHR. Cholesterol and alkali phosphatase are high in high fat and high salt SHR. Blood glucose is high in high carbohydrate, low protein and high salt SHR.

AUTOPSY FINDINGS

The heart enlarged parallel to the grade of hypertension, that is in the order of $S_3 > S_1 > S_2 > C_2 > C_1$.

The kidney of S_2 is larger, that of S_3 is smaller than the normal control.

SUMMARY

The high salt, high carbohydrate and low protein diet induces highest rise in blood pressure than the other diets in Spontaneously Hypertensive Rat. The result is the same which is obtained in experimental renal hypertension. These results of experimental studies would explain one of the reasons why hypertension prevails so high in North-Japan.

(c) Change of nutrition and prevalence of stroke and heart attack.

The intake of protein and fat in average are increasing rapidly in Japan since about ten years.[8] At the same time, the mortality of cerebral infarction and myocardial infarct are stepping up and the trend of the

mortality of cerebral haemorrhage, which relates closely to hypertension, is coming down. The salt intake in northern Japan is still 22 g daily per person, whereas in West-Japan the intake is about 12 g. However, the tendency to reduce the salt intake in northern Japan in very gentle slope.

The increase of protein intake and reduction of salt intake could contribute to the lowering of cerebral bleeding and severe hypertension. The increasing tendency of fat and calorie intake will enhance the mortality of cerebral and myocardial infarction.

The problem of salt and diet will be important even in future for the prevention and treatment in hypertension.

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