韓國農村醫學會誌 : 第 16 卷 第 1 號 1991
Korean J of Rural Med Vol. 16, No. 1, 1991

A Study on Urinary Excretions of Sodium and Potassium and the Volume of 24 Hour Urine in Rural Korean Residents

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한국 농촌거주자의 24시간 채집 소변중 나트륨, 칼륨의 배설량과 일중 총 소변 배설량에 관한 연구

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= 국문초록 =

한국인은 많은 양의 염류를 섭취하며 저단백식을 주로 한다는 사실이 1960년대로부터 알려져왔다.

일련의 연구로부터, 한국인이 많은 양의 염류를 섭취하는 것은 저단백식과 관계가 있는 것으로 여겨져왔다. 지난 30년 간 한국인의 식사 중 단백성분은 크게 증가해 왔다.

본 연구는 1990년 현재 한국 농촌지역 거주자의 소변 중에 배설되는 나트륨과 칼륨의 양 및 총 소변 배설량을 측정하여 유의할 만한 변화가 있었는지를 알아보기 위하여 실시되었다.

또, 도시지역 거주자와의 비교를 위해 34명의 농촌지역 거주자와 9명의 도시지역 거주자를 대상으로 하였다. 조사기간중 조사대상자는 일상생활을 그대로 영위하도록 하였다. 24시간 동안 배설된 소변을 수집하여 그중의 나트륨, 칼륨, 크레아티닌 농도를 측정하였다. 마지막 뇨 수집 시에는 정맥혈을 채취하여 혈장 중의 나트륨, 칼륨, 총단백 농도를 측정하였다.

그 결과는 다음과 같다.

1) 혈장 중의 나트륨, 칼륨, 총단백 농도는 정상범위 내에 있었다.

2) 농촌인구에서는 24시간 소변 중의 나트륨, 칼륨 배설량은 각각 255± 95.6mEq/day, 45± 15.1mEq 이었으며 24시간동안 수집된 소변의 총량은 1800± 514.3ml/day이었다. 이 수치를 1960년의 자료와 비교할 때 뇨중 나트륨 배설량은 감소추세를 보였으나 칼륨과 총 소변배설량에 있어서는 별 변화를 발견할 수 없었다.

3) 농촌거주자의 소변중 Na/K 비는 도시거주자에 비해 유의하게 높았으며 도시지역거주자에 있어서 소변중 나트륨 배설량의 감소추세가 더욱 두드러졌다.

4) 이 수치를 서양인의 수치와 비교하면 아직도 한국 농촌지역 거주자의 염분 섭취가 높음을

보이고 있는 반면 칼륨에 있어서는 서양인에 비해 훨씬 낮음을 알 수 있다.
5) 염분과 단백의 섭취 사이에 있을 수 있는 관계를 고찰했다.

Introduction

In 1960's it was reported that the salt intake and excretion in Koreans is significantly higher than that in the western population, and it was estimated to have strong correlation with the low protein diet.

Daily protein intake was 57g in 1965 but incresed to 89g in 1989, and animal protein increased from 10.7g in 1970 to 30.5g in 1987 due to the improvement of food quality(Chae, 1990).

If the high salt intake was due to the low protein intake as mentioned above, salt intake should have been reduced according to the increased protein intake.

In 1965, urinary sodium excretion of rural population tends to be higher than that of urban population.

The data collected from medical students living in urban are in 1974 tells us that daily sodium excretion had been reduced significantly compared with the data of rural population in 1960, nevertheless somewhat higher than that of western population yet.

The aims of this study are as follows ;

First, we wanted to observe the trend of salt intake as a factor of increased protein ingestion and interprete the correlation between salt and protein intake by measuring the urinary Na^+ and K^+.

Secondly, we wanted to speculate and generalize the differences between rural and urban residents.

Materials and Methods

1. Materials

34 volunteers(13 men and 21 women) living in Hanlim subcounty, Kimhae Kyongnam at the time of December 1990 were selected. They all have no specific subjective physical symptoms. Age distribution of the subjects was as follows ; below 40 : 3, 40−49 : 10, 50−59 : 13, above 60 : 8.

Control urban residents group was composed of 9 healthy middle-aged volunteers(men 4, women 5) who were working in Paik Hospital, Pusan. Age distribution was as follows ; below 40 : 2, 40−49 : 3, 50-59 : 4.

2. Sampling

Volunteers were permitted to do their usual daily work and any dietary restriction was not imposed. Urine was collected for 24 hours to a container washed with distilled water, the last sample was obtained via compulsive urination of remaining urin.

Collected urine was measured and mixed well and was used for the determination of sodium, potassium, and creatinine concentration. Just after the sampling of the urine 10ml of the venous blood was sampled, centrifuged and used to determine plasma electrolytes, total protein, and creatinine concentration.

3. Chemical Analysis and Statistical analysis

Sodium and potassium concentrations were checked by Flame Photometer(Corning Co.), and total protein concentration was checked with Biuret and Jaffe method using Gilford 400E.

Using the data, daily sodium excretion(mEq/day), potassium excretion(mEq/day), and K^+/Na^+ ratio were calculated.

Using urine creatinine concentration and 24 hour urinary volume, Creatinine Clearance was calculated. Statistical difference between rural and urban resident groups was verified using Student test in the confidence range of 98%.

Table 1. Plasma sodium, potassium and total protein concentration of rural residents

Age	Sex	Na^+ (mEq/l)	K^+ (mEq/l)	Total protein (gm/100ml)
	M(1)	145	30.9	6.0
〈 40	F(2)	146± 0.7	3.7± 0.21	6.4± 0.28
	T(3)	145± 0.6	3.7± 0.21	6.3± 0.31
	M(3)	146± 3.6	3.9± 0.28	6.1± 0.12
40—49	F(7)	148± 5.1	3.6± 0.21	6.2± 0.42
	T(10)	148± 4.6	3.7± 0.26	6.2± 0.35
	M(5)	143± 2.7	4.3± 0.27	6.1± 0.33
50 -49	F(8)	146± 4.4	3.9± 0.39	6.2± 0.61
	T(13)	145± 3.9	4.1± 0.38	6.1± 0.51
	M(4)	146± 3.5	3.9± 0.33	6.1± 0.36
〉 60	F(4)	146± 4.0	3.9± 0.29	6.2± 0.56
	T(8)	146± 3.5	3.9± 0.29	6.2± 0.44
	M(13)	145± 5.0	4.1± 0.31	6.1± 0.27
Total	F(21)	147± 4.3	3.8± 0.33	6.2± 0.49
	T(34)	146± 3.9	3.9± 0.35	6.2± 0.42

Data show mean ± S.D. Numbers in parentheses are numbers of subjects.

Results

1. Plasma $Na^+ \cdot K^+$, and total protein concentrations

Mean plasma sodium, potassium and total protein concentrations were 146± 3.9mEq/l, 3.0± 0.35 mEq/l and 6.2± 0.42g/dl respectively in that order.

Table 1 shows the Plasma $Na^+ \cdot K^+$, and total protein concentrations in each of the age and sexual groups.

2. Urinary $Na^+ \cdot K^+$ concentration and Creatinine Clearance

Urinary mean concentrations of Na^+ and K^+ were 142± 33.1mEq/l and 25.2± 6.83mEq/l respectively and there was no significant difference between age or sex groups. Table 2 shows the urine volume, daily urinary excretion of Na^+ and K^+, and creatinine clearance.

Daily urinary excretion was 1800± 514.3ml/day, and there was no sexual difference. But in the age group above 69 it showed a little lower figure.

Daily mean excretions of Na^+ and K^+ were 255± 95.6mEq/day and 45mEq/day respectively, and creatinine clearance was 256± 96.7 l/day.

3. Comparison with the urban residents in the urinary Na^+, K^+ and water excretion

Daily urinary volume of urban residents showed 1,867± 44.7ml/day, and exhibits no difference from rural residents. But daily Na^+ excretion showed 209± 83.9mEq/day and was lower than that of rural residents. K^+ excretion was higher in urban resident group(50mEq/day) but this was not significant statistically.

Urban residents showed significantly higher urinary K^+/Na^+ ratio(0.247± 0.1275) than rural residents(0.184± 0.05961) ($p<0.05$).

Discussion

In the situation of bleeding, diarrhea, and severe perspiration human body needs more than usual amount of salt and in these cases excess amount of salt operates positively to the human body. But by and large, excessive intake of salt was thought to have negative effects to health. It had been known that there is a correlation between the incidence of hypertension and the

Table 2. Urin volume, urinary sodium and potassium excretion and creatinine clearance of rural residents

Age	Sex	Urin Volum	U_{Na} (mEq/L)	U_K (mEq/L)	Urin K/Na	$U_{Na}V$ (mEq/day)	U_KV (mEq/day)	Creatinine (L/day)
	M(1)	1550	220	24.3	0.110	341	38	242
〈 40	F(2)	1850± 353.6	162± 11.3	29.1± 10.61	0.178± 0.0530	298± 36.1	52± 9.9	317± 86.3
	T(3)	1750± 304.1	181± 34.4	27.5± 8.00	0.155± 0.0540	312± 35.8	47± 10.7	292± 74.8
	M(3)	1800± 458.3	146± 3.5	28.5± 6.31	0.195± 0.0495	263± 65.3	50± 12.9	274± 98.1
40−49	F(7)	2029± 482.1	114± 29.5	25.7± 6.16	0.237± 0.0736	226± 56.2	52± 16.0	311± 103.1
	T(10)	1960± 462.4	124± 28.7	26.6± 6.00	0.225± 0.0670	237± 58.2	51± 14.4	300± 95.7
	M(5)	1890± 632.9	141± 15.0	28.7± 10.56	0.206± 0.0807	268± 92.3	49± 8.2	320± 95.0
50−49	F(8)	1881± 452.7	107± 42.0	19.9± 4.48	0.151± 0.0330	285± 131.6	38± 15.6	190± 43.4
	T(13)	1885± 503.1	139± 33.3	23.3± 8.30	0.172± 0.0600	265± 113.7	43± 14.0	240± 91.0
	M(4)	1475± 741.1	168± 26.1	27.5± 6.64	0.164± 0.0322	259± 155.7	41± 22.0	273± 103.7
〉 60	F(4)	1488± 505.6	146± 9.1	23.9± 2.63	0.164± 0.0131	219± 84.3	37± 16.6	154± 53.8
	T(8)	1481± 587.3	157± 21.6	25.7± 5.06	0.164± 0.0227	239± 117.9	39± 18.2	214± 99.6
	M(13)	1715± 584.7	157± 27.4	28.0± 7.51	0.183± 0.0601	269± 100.4	46± 13.0	289± 89.6
Total	F(21)	1852± 473.1	134± 33.8	23.5± 5.92	0.185± 0.0607	246± 94.0	44± 16.1	235± 97.4
	T(34)	1800± 514.3	142± 33.1	25.2± 6.83	0.184± 0.0596	255± 95.6	45± 15.1	256± 96.7

Excretion between rural and urban residents

* indicates $p<0.05$

amount of salt intake. For example, the incidence of hypertension of Alaskan tribe who take 4mg of salt a day is very rare, that of Bantu tribe who take 18.6mg a day is 22%, and that of northern Japanese who take 28mg a day in 38%.

But, this argument was based only on the intake of salt and did not take the intake of other nutritional components into consideration. Urinary Na^+ excretion reflects the amount of salt ingested and it follows that the Na^+ treatment capacity of kidney varies according to the amount of salt intake. In medulla and renal papillae osmotic pressure is 4 times higher than in other tissues and urea constitutes 50% of the osmosis, so if one takes low protein diet, it may have effects on the salt and water metabolism. Therefore, it can be argued that Koreans' large amount of salt intake is attributable in part to the low protein diet.

If protein intake is increased for rats which have experimentally induced hyponatremia, Na^+ concentration increases improving the hyponatremia. Urea has the same effect as protein and causes increased concentration of urea in medulla of kidney(Verbaliseta, 1988). On the contrary if the protein intake is increased for high salt diet induced hypertensive rats, urinary Na^+ excretion increases to improve the side effects of high salt diet.(Wabgetal, 1985).

It was observed that if one imposes high protein diet to rats which have high salt load, arterial blood pressure becomes significantly lower than when one imposes low or usual amount of protein. It was argued that increased protein intake promotes the Na^+ excretion and activates kallikrein-kinin system to restrain the rise of mean blood pressure(Kojima and Ito, 1988).

From the above mentioned observations, it can be said that protein controls the urinary Na^+ excretion and improves the Na^+ metabolism in both cases body Na^+ is deficient or excessive. Therefore it is possible that increased protein intake

of Koreans for the last 30 years, may have altered the Na^+ metabolism.

In 1960's, salt intake of Koreans was almost 2 times the western population(Lee, 1965 ; Choi, 1966), but in 1970's Na^+ excretion of medical students who live in urban area approached that of western population(Hur and Kim, 1974). Protein intake of rural residents was less than that of urban residents in 1960's (Lee, 1965).

So it follows that if high salt intake of Koreans was caused only by the low protein diet, recent economic development and improved diet quality may have increased protein intake and decreased Na^+ excretion.

Daily Na^+ excretion of rural residents found in this study 255± 95.6mEq/day shows significantly lower figure compared to the figure in 1960. 374mEq/day, but higher than that of occidentals 160mEq/day yet(Cunningham, 1989).

From the above mentioned findings, relatively high Na^+ excretion of Koreans compared to the occidentals cannot be argued strictly to be the result of low protein intake but it can be inferred that increased protein ingestion has contributed in part to the decreased intake of salt.

Luft et al.(1983) stated that when salt and protein in the range of 10−400mg and 80−100mg respectively was supplied to the normal Americans, excretion of salt and nitrogen varied correspondingly but could not observe significant variation in water intake and excretion.

In 1990 daily protein intake of a Korean has reached 89.9mg and the increased amount of protein is thought to control the Na^+ metabolism without varing the water intake.

Summary

We measured volume of daily urinary excretion, daily excretion of Na^+ and K^+, creatinine clearance, blood Na^+ and K^+ concentration on 34 subjects(12 men, 21 wenen) who live in Hanlim subcounty, Kimhae county, Kyongnam, Korea in December 1990. The data were compared to the data in 9 urban residents(4 men, 5 wemen).

Results were as follows.

1) Daily mean urinary Na^+ excretion of rural residents was 255± 95.6mEq/day. It is much lower than that of in 1960 but higher than that of students living in urban area(1975) or that of occidentals.

2) Daily mean urinary K^+ excretion of rural residents was 45± 15.1mEq/day.

3) K^+ excretion of rural residents was similar to that of urban residents but because of the relatively high Na^+ excretion, K^+/Na^+ ratio was significantly lower than that of urban residents.

In conclusion, salt intake and excretion of rural residents tends to have been decreased progressively and it is thought to be the result of the improvement in dietary life especially increased intake of animal protein.

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