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Medical Sciences

Effects of DASH and Sodium-Restricted Diets on Blood Pressure in Normotensive Elderly

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ABSTRACT. During the past century, the evidence for the risks imposed on human health by excess salt consumption was compelling. The causal relation between habitual dietary salt intake and blood pressure has been established through experimental, epidemiological, migration, and intervention studies. The aim of the work was to select from persons having normal arterial pressure the salt sensitive ones and using DASH and sodium-restricted diets to set the perspective for the development of preventive measures. Salt sensitivity was assessed in normotensive 54 young and 68 elderly males. Accordingly salt sensitive subjects were divided into two groups in accordance with age. Salt sensitivity was assessed by the difference of mean arterial pressure (MAP) on high (200 mmol/day) vs. low (40 mmol/day) salt diet. Compliance with the diet was confirmed by measurement of 24-hour urinary sodium excretion during the last 2 days of both weeks. As was mentioned, both the DASH diet and DASH diet with lower sodium intake caused mean arterial pressure decrease, but the combination of the DASH diet plus lower sodium intake consistently produced the greatest mean reductions in blood pressure with peak levels in the elderly. Based on our results, we can suggest that in spite of the fact that diet modifications cannot influence the genetic nature of salt sensitivity, it can lower the mean arterial pressure in normotensive salt sensitive individuals, thus creating the possibility of its use for hypertension prevention. *© 2011 Bull. Georg. Natl. Acad. Sci.*

Keywords*: salt sensitivity, mean arterial blood pressure, DASH diet.*

Hypertension accounts for 6% of adult deaths worldwide and is found in all human populations. In developed countries, the prevalence of hypertension rises with age and affects 25-30% of the entire adult population, reaching up to 60-70% of individuals beyond the seventh decade. The cardiovascular risk increases according to the level of hypertension [1]. Furthermore, this risk increases with progressive elevations in blood pressure, beginning at even normal levels of blood pressure [2]. High dietary sodium has been adduced as a cause of hypertension and its target organ damage for millennia [3].

During the past century, the evidence for the risks imposed on human health by excess salt consumption became compelling. The causal relation between habitual dietary salt intake and blood pressure has been established through experimental, epidemiological, migration, and intervention studies [4].

Sodium intake in most industrialized societies averages 3.5 g/day (150 mmol/day, range 120–200 mmol/day), a figure far in excess of the minimal daily requirement. Salt is a major food additive, and is important for food preservation as well as taste enhancement. The role of dietary sodium in health and disease has been a topic of great interest and debate for many years.[3].

While blood pressure in the population as a whole is only modestly responsive to alterations in sodium intake, some individuals manifest large blood pressure changes in response to acute or chronic salt depletion or repletion, and are termed “salt sensitive”. Salt sensitivity is defined as the tendency for blood pressure to

fall during salt reduction and rise during salt repletion/ supplementation [5].

Salt sensitivity and resistance have a large variety of determinants, including genetic factors, race/ethnicity, age, body mass and diet (overall diet quality, macro- and micronutrient content), as well as associated disease states, e.g. hypertension, diabetes and renal dysfunction [3].

Salt sensitivity in both normotensive and hypertensive persons has been associated with increased cardiovascular disease events and reduced survival. Increased attention to strategies that reduce salt sensitivity, i.e. improvement in diet quality and weight loss, particularly in high risk persons, is urgently needed. [3,2]. In normotensive as well as hypertensive subjects, blood pressure can be judged to be "salt sensitive" when observed to vary directly and substantially with the net intake of sodium chloride. From both a clinical and public health perspective, the phenomenon of normotensive salt sensitivity may be important. Not only is normotensive salt sensitivity a likely and possibly common precursor of hypertension, but the phenomenon might be susceptible to dietary suppression, which could prevent or delay its progression to hypertension (vide infra) [6].

The Dietary Approaches to Stop Hypertension (DASH) trial demonstrated that a diet that emphasizes fruits, vegetables, and low-fat dairy products, that includes whole grains, poultry, fish, and nuts, that contains only small amounts of red meat, sweets, and sugar-containing beverages, and that contains decreased amounts of total and saturated fat and cholesterol lowers blood pressure substantially both in people with hypertension and those without hypertension, as compared with a typical diet in the United States. The DASH diet is now recommended in national guidelines. (The sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure). Clinical trials have shown that reducing the sodium chloride content of typical diets in the United States or northern Europe lowers blood pressure [7] and guidelines recommend reducing the daily dietary sodium intake to 100 mmol (equivalent to 2.3 g of sodium or 5.8 g of sodium chloride) or less (The sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure). DASH diet has been proved to have substantial blood pressure (BP)-lowering action and is now recommended as one of the most important nonpharmacological measures to control BP [8]. Blood pressure-lowering mechanisms of the Dietary Approaches to Stop Hypertension (DASH) were analyzed based on the pressure-natriuresis relationship [9].

The aim of the work was to select from persons having normal arterial pressure the salt sensitive ones and using DASH and sodium-restricted diets set the perspective for development of preventive measures.

Numerous methods of assessment of salt sensitivity [10,11] are mostly based on changes in mean arterial pressure (MAP) after being on various salt diets (low, normal and high salt intake). Most of the salt sensitivity study protocols imply administration of a low (9 to 80 mmol/ day) sodium diet for 4 to 14 days, followed by a high (220 to 300 mmol/day) sodium intake for 4 to 14 more days. If MAP increases mo more than 3 mmHg, a person is considered to be salt sensitive.

Methods

Salt sensitivity was assessed in normotensive (blood pressure < 139/89 mm Hg) 54 young and 68 elderly males with mean age 33.5 ± 4.0 yrs and 69.5 ± 3.0 yrs respectively. Salt sensitive subjects were divided into two groups in accordance with age (young age salt sensitives - SS1, elderly salt sensitive subjects - SS2; respectively, salt resistant subjects were divided into two groups SR1 and SR2). Salt sensitivity was assessed by the difference of mean arterial pressure (MAP) on high (200 mmol/day) vs. low (40 mmol/day) salt diet [10]. During the first week the subjects were placed on high sodium diet (200 mmol/d per 70 kg) both by adding 100 mmol directly to the food and by adminitsring 100 mmol in capsules ingested 3 times daily with meals. Next week subjects were placed on a low-salt diet aimed at a maximum intake of 40 mmol sodium per day. Compliance with the diet was confirmed by measurement of 24-hour urinary sodium excretion during the last 2 days of both weeks. On the seventh day of both weeks the diastolic blood pressure (DBP) and systolic blood pressure (SBP) were measured in sitting position at 2-minute intervals for 1 hour by automatic Blood Pressure Monitor BP A100 Plus (Microlife, Switzerland). Mean arterial blood pressure (MAP) was calculated as DBP plus one-third of the difference between DBP and SBP. Salt sensitivity of blood pressure was defined as the difference of MAP between the average of 30 readings during the high and low salt periods. Salt sensitivity was considered when difference between MAP exceeded 3 mm Hg. All subjects were volunteers and nonsmokers. They did not use any medicine and did not have history of cardiovascular, respiratory, liver, renal diseases and diabetes. All patients signed an informed consent.

Statistical analyses were performed using SPSS software. All data are presented as mean ±SD. Statistical comparison among groups was performed by Student's t test. A value of $p<0.05$ was considered significant.

Table.

Blood pressure and biochemical measurements in SS and SR Groups

Variables	SS1		SS2		SR1		SR2	
	low salt	*high salt*	*low salt*	*high salt*	*low salt*	*high salt*	*low salt*	*high salt*
n	17		28		37		40	
SBP mm Hg	112.5±1.2	122.2±1.3^{a}	116.8±1.5	131±1.6^{b*}	116.8±1.4	121.5±1.7	123.4±1.6	124±1.4
DBP mm Hg	73.6±1.2	77.1±1.1	72.2±1.1	80.4±1.1^{a}	74.9±1.2	76.7±1.4	75.8±1.2	78.3±1.2
MAP mm Hg	86.7±0.98	92.4±1.1^{a}	86.1±1.2	99.3±1.3^{a*}	89.2±1.1	91.5±1.5	92.3±1.4	94.3±1.4
UNa/day mmol	32.3±6.3	167±26.1^{c}	27.4±4.9	164±31.5^{c}	28.6±6.4	173.3±24.7^{c}	30.4±4.8	181.5±19.6^{c}

p<0.05; b-<0.01; c-<0.001 vs. low salt diet. * - p<0.05 vs. middle aged group(SS1)

Results

Results of salt sensitivity test are presented in Table. 17(31.4%) of young subjects and 28 (48.2%) of elderly subjects were salt sensitive (Groups SS1 and SS2 respectively). Those who did not respond to sodium diets by changes in MAP (≤3mmHg) were considered salt resistant (Groups SR1 and SR2).

By the end of low salt diet SBP, DBP and MAP of salt sensitive middle-aged subjects (SS1) did not differ from those of Group SS2. High salt diet induced significant elevation of SBP and MAP in both salt sensitive groups, predominantly in elderly subjects (SS2). Whereas difference between basal and post-loading MAP in SS1 was 5.5±0.43 mm Hg, p<0.05), in SS2 it became more prominent (13.2±0.31mmHg, p<0.01). Predictably, in salt resistant subjects, blood pressure parameters including MAP did not change significantly in both groups. After salt loading urinary sodium excretion increased both in salt sensitive and salt resistant subjects irrespective of their age.

After establishing salt sensitivity, one group of patients was on DASH diet and the second group was on DASH diet with lower sodium intake. After 3 months from the diet starting point, mean arterial pressure (MAP) was measured in every person.

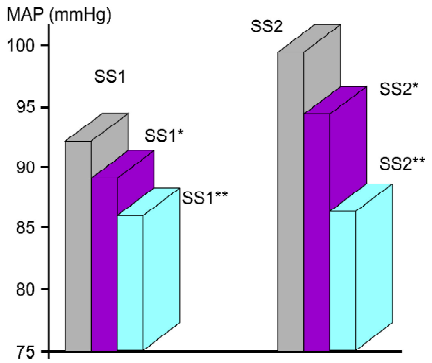

Fig. The change of mean arterial pressure on DASH diet and DASH diet with lower sodium intake

Both groups (SS1 and SS2) of salt sensitive persons where subdivided (SS1*, SS1**, SS2* and SS2**). DASH diet was administered to SS1*(9) and SS2*(14) and DASH diet with lower sodium intake was administered to SS1**(8) and SS2**(14). In all 4 groups the mean arterial pressure was found to be diminished, but a comparison of the SS1* group with the starting data revealed a trend of decrease of mean arterial pressure (p<0.5) and for SS1** group this decrease was more significant (p<0.01). In the elderly both the DASH diet and DASH diet with lower sodium intake cause arterial pressure decrease in both groups (p<0.01; p<0.001), but this decrease was more statistically significant for DASH diet combination with lower sodium intake.

Discussion

Salt sensitivity, despite being a subject of long-term discussions, remains an actual problem. Our findings confirm the results of numerous studies that demonstrate age dependence on salt sensitivity. We found that high salt diet led to significant increase in SBP and MAP only in salt sensitive subjects with peak levels in the elderly. However, our primary interest was focused on investigating whether any differences exist in normotensive young and elderly subjects who are salt sensitive and salt with respect to changes in blood pressure, urinary sodium excretion during sodium restriction and salt loading.

As mentioned above, both the DASH diet and DASH diet with lower sodium intake caused mean arterial pressure decrease, but the combination of the DASH diet plus lower sodium intake consistently produced the greatest mean reductions in blood pressure with peak levels in the elderly.

Based on our results, we can suggest that in spite of the fact that diet modifications can't influence the genetic nature of salt sensitivity, it can lower mean arterial pressure in normotensive salt sensitive individuals, thus creating the possibility of its use for hypertension prevention.

სამედიცინო მეცნიერებანი

DASH-ის და დაბალმარილიანი დიეტის გავლენა არტერიული სისხლის წნევაზე ნორმოტენზიულ ხანდაზმულებში

ი. ანდრონიკაშვილი*, გ. სიმონია*, ნ. ბასიშვილი*

** თბილისის სახელმწიფო სამედიცინო უნივერსიტეტი*

(წარმოდგენილია აკადემიკოს ვ. ოკუჯავას მიერ)

გასულ საუკუნეში დაგროვდა არაერთი მტკიცებულება იმის სასარგებლოდ, რომ მარილის ჭარბი მოხმარება საზიანოა ადამიანის ჯანმრთელობისთვის. მიზეზობრივი კავშირი საკვებით მარილის მოხმარების ჩვევასა და სისხლის წნევას შორის დადგენილი იქნა ექსპერიმენტული, ეპიდემიოლოგიური, მიგრაციული და ინტერვენციული კვლევებით. ჩვენი კვლევის მიზანი იყო ნორმალური არტერიული წნევის მქონე ადამიანებიდან მარილმგრძნობელი პირების შერჩევა და DASH-ის და დაბალმარილიანი დიეტის გამოყენებით პრევენციული ღონისძიებების შემუშავების პერსპექტივის დასახვა. მარილმგრძნობელობა განისაზღვრა ნორმოტენზიულ 54 ახალგაზრდა და 68 ხანდაზმულ მამაკაცში. მარილმგრძნობელი პირები ასაკის შესაბამისად დაიყვნენ ორ ჯგუფად. მარილმგრძნობელობის განსაზღვრა ხდებოდა მაღალმარილიანი (200 მმოლი/დღეში) და დაბალმარილიანი (40 მმოლი/დღეში) დიეტის დროს არსებული საშუალო არტერიული წნევის სხვაობით. დიეტის ადეკვატურობა მტკიცდებოდა თითოერული კვირის ბოლო 2 დღეში ნატრიუმის შარდში ექსკრეციის 24-საათიანი განსაზღვრით. DASH დიეტა და DASH დიეტა დაბალი მარილის მოხმარებით, ორივე იწვევდა საშუალო არტერიული წნევის დაქვეითებას, მაგრამ DASH დიეტის დაბალმარილიან დიეტასთან კომბინაცია იწვევდა სისხლის წნევის დაქვეითების ყველაზე მაღალ საშუალო მონაცემებს, მაქსიმალური ეფექტით ხანდაზმულებში. ჩვენი შედეგებიდან გამომდინარე, შეგვიძლია დავუშვათ: მიუხედავად იმისა, რომ დიეტის მოდიფიკაციას არ შეუძლია გავლენა მოახდინოს მარილმგრძნობელობის გენეტიკურ ბუნებაზე, მას შეუძლია შეამციროს საშუალო არტერიული წნევა ნორმოტენზიულ მარილმგრძნობელ პირებში, რაც ქმნის ესენციური ჰიპერტენზიის განვითარების პრევენციის მიზნით მისი გამოყენების შესაძლებლობას.

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