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TEA AND COFFEE AS THE MAIN SOURCES OF OXALATE IN DIETS OF PATIENTS WITH KIDNEY OXALATE STONES

HERBATA I KAWA JAKO GŁÓWNE ŹRÓDŁA SZCZAWIANÓW W DIECIE PACJENTÓW Z KAMICĄ SZCZAWIANOWĄ

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We analyzed nutritional habits of 22 stone formers with special regard to oxalate content as one of the main nutritional lithogenic factors associated with kidney stones. Daily dietary oxalate intake was 354 ± 261 mg and 406 ± 265 mg in men and women respectively. These values were much higher than those found by other researches. The main sources of oxalate in diets were regular tea and coffee (80-85%). Only 15-20% of oxalate was derived from other plant foods. Patients did not adhere to high fluid diet and, what is more, as common beverage they chose rich-oxalate black tea.

Key words: kidney stones, dietary oxalate, tea and coffee, nutrition
Słowa kluczowe: kamienie nerkowe, szczawiany w diecie, herbata i kawa, żywienie

INTRODUCTION

Kidney stones are one of the most common diseases in industrialized countries and their prevalence ranges from 1 to 10 % [17]. The mechanism of stone formation begins with supersaturation urine with salts, nucleation (forming nuclei), crystal growth and agglomeration. Small crystals (below 0,1 μm) are unstable and can dissolve, but a large amount of ions in solution, which hit in surface of crystal and bind with them, increase their size. Crystal particles aggregate than in stones in tubule [9]. Calcium oxalate (CaOx) stones are the most prevalent form of kidney stones (approximately 70 – 80 % of the all kidney stones). Twenty-five percent of these stones exist in the pure form, the remaining stones are associated with calcium phosphate (CaP) [24]. The others calculi contain struvite (ammonium-magnesium phosphate), uric acid, brushite (calcium monohydrogen phosphate), hydroxyapatite, cystine [1, 17].

Abnormalities in urinary composition may result from nutritional-environmental, genetic or metabolic factors [16]. Age, gender, occupation, dietary and drinking habits, diseases and medications can cause aberration in urine composition resulting in supersaturation with CaOx

or CaP [24]. The most important determinants for calcium oxalate crystallization in urine are hyperoxaluria, hipercalciuria and hipocitraturia. Oxalate acid is an end-product of aminoacids metabolism in organism and can also be derived from plant foods (for example spinach, rhubarb, beets, tea, chocolates, nuts, berries) [1]. An excessive intake of products rich in oxalate is a possible factor that contributes to mild hyperoxaluria. Mainly the ingestion of oxalate-rich product such as chocolate and nuts between regular meals can be a source of particularly high concentration of urinary oxalate [24]. Reduction of dietary oxalate and adequate calcium intake has been shown to decrease urinary oxalate concentration. In addition, high water intake increases urinary volume which reduces the concentration of lithogenous salts [14]. In our study we try to estimate the main food sources of oxalate in free-choice diets of patients with nephrolithiasis as well as other nutritional lithogenic factors.

MATERIAL AND METHODS

Twenty two stone forming adults, 12 men and 10 women, completed the study. Subjects were recruited from two polish medical centers. Patients with hyperparathyroidism, primary hyperoxaluria or other definite causes of hypercalciuria and hyperoxaluria were excluded from the study [1]. Eighteen subjects had a long medical history of renal disease and 16 of them were recurrent stone formers. First stone was diagnosed in four patients. Calcium oxalates were the most common components of calculi (36 %). Anthropometric measurements including weight and height were done according to standardized procedures. Body mass index (BMI) was calculated as weight (kg) divided by height (m^2). Overweight was defined as BMI ≥ 25 m/kg^2, obesity was defined as BMI ≥ 30 m/kg^2 [26]. Participants' characteristics are summarized in Table I. Analysis of eating habits and nutrition were performed by food-frequency questionnaire (FFQ) and 3-day food record. Calcium, vitamin C and vitamin B_6 intakes were calculated with the aid of computer program Dietetyk, based on Food Composition Tables [10]. These data were then compared with the Polish DRI [27]. The intake of oxalate was estimated on the basis of food composition tables by *Souci* et al. [21] and table with oxalate concentration in tee and coffee by *McKay* et al. [13]. Results are presented as means ± SD. Vitamin C, because of lack of normal distribution, was logarithmically transformed [22]. The difference between men and women were assessed by Student's *t* test and nonparametric *Mann – Whitney* test (STATGRAPHICS Plus 4.0). Patients didn't receive any dietetic counseling before study.

Table I. Characteristics of stone formers (n = 22)
Charakterystyka pacjentów z kamicą nerkową (n = 20)

Parameter	Men	Women
Number of patients	12	10
Age (years)*	46.7 ± 16.5 (23 – 75)	51.1 ± 11.8 (40 – 76)
BMI (kg/m^2) #	27.9 (22.5 – 34.9)	25.6 (21.6 – 28.9)
Overweight patients BMI ≥ 25 (%)	42	50
Obese patients BMI ≥ 30 (%)	25	0

* - mean ± SD (95 % limits),

- median, $p < 0.05$, *Mann – Whitney* test

RESULTS AND DISCUSSION

In our study 67 % of men and 50 % of women had BMI higher than reference values. *Curhan* et al. [5] reported that high body mass can increase stone risk, mainly in females. In contrast, *Meschi* et al. [14] observed that increased BMI corresponds to an increased incidence of kidney stone in both, adult males and females. They also found that even a small drop in body weight in patients with kidney stone is associated with a reduction of lithogenous salts in patients' urine.

Table II. Nutrient and fluid amount in free-choice diets of stones formers
Zawartość składników pokarmowych i płynów w diecie pacjentów z kamicą nerkową

Parameter	Men		Woman		
	Mean ± SD	Range	Mean ± SD	Range	p
Fluids* (L)	2.4 ± 1	1.15 – 4.5	1.6 ± 0.7	0.7 - 3	< 0.05
Oxalic acid* (mg)	353.9 ± 261.5	1 – 1027.5	405.9 ± 265	10 – 1213	NS
from plant foods (%)	20		15		NS
from tea and coffee (%)	80		85		NS
Calcium* (mg)	511.1 ± 257.2	51 - 1168	351.1 ± 179.9	83 - 684	< 0.05
Vitamin B_6* (mg)	1.74 ± 3.65	0.79 – 3.65	1.57 ± 0.41	0.8 – 2.3	NS
Parameter	Median	Range	Median	Range	p
Vitamin C# (mg)	91.2	10 – 664	100.3	17.8 – 229	NS

* - *Student* t test,
\# - *Mann - Whitney* test

Table II presents mean daily dietary intake of fluid and selected nutrients by stone formers. Mean total dietary oxalate intake for 3 days was unexpectedly much higher than we found in other studies. *Siener* et al. [20] estimated that diets of the patients with hyperoxaluria contained 130 mg/day of oxalate, as compared to 101 mg/day of oxalate among patients without hyperoxaluria. In *Massey* and *Kynast-Gales* study [11] two moderate-oxalate diets contained 316 mg and 304 mg of oxalate. *Holmes* and *Assimos* [8] suggested that the mean intake of oxalate in Western diet is 100-150 mg/day. Furthermore, regional and cultural differences in the amount of oxalate ingested may be related to season or food availability. The important source of oxalic acid are foods of plant origin beverages, such as tea, coffee and beer. In our study we observed that oxalate-rich vegetables, such as spinach, rhubarb and beets were consumed occasionally (few times per month). Four patients claimed a daily consumption of chocolate. Only 20 % of total oxalate intake in group of men and 15 % in group of women were derived from plant sources (without significant difference).

The main sources of oxalate in our study were beverages, such as regular tea and coffee, despite the fact that regular black tea is known to have a high oxalate concentration. All patients drank more than two cups of coffee or tea a day. One of them consumed 10 cups of black tee daily. *Mc Kay* et al. [13] suggested that persons who drink four serving (1L) of black tea per day may increase their 24-hour urinary excretion of oxalate by 105 to 185 μmol. For reducing the risk of urinary stones the American Dietetic Association (ADA) [15] recommends the intake of less than 40 – 50 mg oxalate/day. *Tiselius* et al. [23] suggested that high urinary oxalate might occasionally be the result of excessive intake of oxalate-rich food and

is primarily due to metabolism. The amount of absorbed oxalate can differ between normal individuals and stone formers [8]. *Von Unruh* et al. [25] assessed amount of oxalate absorption (after given a capsule containing 0.37 mmol sodium $^{13}C2$ oxalate) by patients with recurrent nephrolithiasis. This reference value was 2.2 % to 18.5 %. Unfortunately none of our patients had urinary concentration of oxalate measured in medical center, which is one of the principles in the management of people with nephrolithiasis on the world [23]. Therefore we did not study the influence of dietary oxalate intake on urinary excretion. *Hess* [7] suggested that small increases in urinary oxalate concentration are much more important than relatively large increases in calcium for raising the level of urine supersaturation with calcium oxalate, so there is no reason to advise patients with kidney stone to consume low-calcium diet. There is no evidence for the benefits of low calcium diet in preventing stone recurrence.

To reduce the risk of stone formation ADA [15] recommends 800 mg/d of calcium for men and 1200 mg/d for women (preferably with meals to reduce intestinal absorption of oxalate). Daily intake of calcium by our patients was much lower and amounted to 511 ± 257 among men and 351 ± 179 among women. *Savage* et al. [18] showed that consuming black tea with milk decreased by two fold the availability of soluble oxalate. *Brogren* and *Savage* [2] found that consumption of spinach with milk products (sour cream and Calci-Trim milk) decreased the bioavailability of oxalate over both 6 and 24 h period after intake. *Massey* and *Kynast-Gales* [11] found that substituting milk (360 ml daily) for apple juice (540 ml) with meals in a diet containing moderate amounts of dietary oxalate decreased urinary oxalate excretion by 90 μmol. In our study patients did not add milk to tea or coffee. Perhaps in the future one solution for stone formers, who like spinach, will be genetically modified the low oxalate variants [6].

As mentioned above, an average intake of oxalate was high and calcium intake was very low, so calcium: oxalate ratio in diet was about 1:1. This condition could result to calcium oxalate crystallization to form very insoluble products. Calcium can also blend with other nutrients like free fatty acids in intestine, what facilitate oxalate absorption [19]. Therefore calcium oxalate ratio should be much higher than 1:1.

High fluid intake is widely recommended to reduce the recurrence of renal stone, but patients should be advised to avoid tea, coffee or cola and to limit these beverages to 1-2 cups/day. ADA [15] recommends 12 to 16 cups of beverages to produce a urine value > 2.5 L. In our study patients did not adhere to high fluid intake. The total fluid intake was significantly higher in group of men than in women (2.4 L versus 1.6 L). Fluid consumption among women was lower than values recommended in stone disease 3 L/d.

Vitamins C and B_6 are among factors that influence urinary oxalate production and secretion, and may alter the risk of stone formation [4]. In our study the mean daily intake of vitamin C was relatively high (above recommended value of 60 mg/day) and an average intake of pyridoxine was below the recommended 2 mg/day. Pyridoxal phosphate, one of the forms of vitamin B_6, is a cofactor for an enzyme transaminating glyoxylate to glycine. Deficiency of this vitamin indicates convertion glyoxylate to oxalate [12]. Vitamin C can be metabolized to oxalate, but only high supplementation (2 g/d) significantly increase endogenous oxalate synthesis [3]. *Curhan* et al. [4] observed inversely correlation between a high intake of vitamin B_6 and risk of stone formation in women and proved the hypothesis that high intake of vitamin B_6 reduces the risk of stone formation in women. In contrast, *Massey* et al. [1997] found out that in young women depletion of vitamin B_6 do not increased urinary oxalate excretion. In *Cur-*

han et al. [4] prospective study, the intake of vitamin C was not associated with risk of stone formation, but the safest course for people who form oxalate stone is to avoid mega doses (1 g of more per day) of vitamin C.

CONCLUSIONS

Renal stone formation is strongly influenced by dietary habits. Excess oxalate consumption and low-calcium diet could increase intestinal absorption of oxalate leading to hyperoxaluria. Patients with kidney stone should be instructed to reduce intake of oxalate-rich drinks/food and to keep fluid intake high. Calcium from dairy products, preferably with meals to reduce intestinal absorption of oxalate, should be considered. Appropriate nutrition management remains a cornerstone in the treatment of stone formers and must be provided by a dietitian. Among golden rules for an anti-stone-forming diet are: limited oxalate intake, a normal calcium intake and increased water intake. Any of these rules was respected by patient in our own investigation.

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Summary

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Streszczenie

Kamica układu moczowego jest chorobą przewlekłą. Tworzeniu złogów sprzyja przesycenie moczu nierozpuszczalnymi solami. Najczęściej diagnozowanym rodzajem kamicy jest kamica szczawianowa, wynikająca z rozwoju hiperoksalurii. Poszukując źródeł szczawianów w diecie przeanalizowano (w ujęciu jakościowym i ilościowym) sposób żywienia 22 pacjentów z czynną kamica nerkową. Stwierdzono znacznie wyższą podaż litogennego kwasu szczawiowego (głównie z napojów typu herbata i kawa) niż antylitogennych składników takich jak wapń, witamina B_6 i całkowita ilość płynów. Wyniki te potwierdzają konieczność edukowania pacjentów z kamicą nerkową w zakresie prawidłowego żywienia oraz monitorowania sposobu żywienia.

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