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SUSTAINABLE PREVENTION OF RENAL CALCULUS IN URINARY SYSTEM

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Introduction: Kidney stone (renal calculus, lat. nephrolithasis, urolithasis) is the third most frequent urinary disease. It occurs on the entire world and affects up to 5% of the population between 30 and 50 years old which indicates that the disease is a serious social issue. A significant role in ethiology of the disease is a diet. Aim: The prevention of kidney stones in urinary system and their recurrence. Dietary recommendations in kidney stone may vary depending on the kind of kidney stones. Proper nutrition in people suffering from renal calculus may be crucial in treatment. The diet ought to cover an individual's calorie requirement and provide proper and balanced amount of macro-and micro-nutrients. The patient has to be provided with carefully elaborated diet plan according to their individual needs regarding renal function, age, nutritional condition and metabolic disorders. Since there is no way to analyze the precipitation, making particular nutrition recommendations is not always possible thus, there have been elaborated nutrition guidelines to prevent kidney stones. Conclusion: The most effective way of prevention of renal calculus is limiting the intake of animal proteins, increasing the consumption of fruit and vegetables, decreasing the amount of salt in diet, regulated intake of calcium and proper hydration of the system.

Keywords: Renal calculus, Kidney stones, Nutritional therapy, Prevention, Hyperkalciuria

INTRODUCTION

Kretowicz and Mianitius (2005) describe kidney stones (lat. *nephrolithasis, urolithasis*) as a chronic, systemic disease that is characterized by creating and existence of calculi in renal pelvis and kidney parenchyma. The calculi is created by components of either healthy or pathologically changed urine. The disease may be primary (the causes of metabolic orders are unknown) or secondary (e.g., urinary system defect, small intestine diseases, disturbances in the serum calcium and phosphorus concentration, caused by other systemic diseases).

Calculi is precipitated in urinary tract as a result of disturbances between crystalloids and natural crystallization inhibitors in urine. The factor catalyzing this process is bacteria and lining, inducing nucleation and the reaction of the urine facilitating precipitation of some of its compounds. When calcium salts are deposited in urinary tract, an individual suffers from calcium oxalate stones (Wieczorkiewicz-Plaza, 2008).

Kidney stones affect around 5% of adult population. Moreover, as much as 12% of population developed the disease in USA (Tiselius, 2003). According to National Health and Nutrition Survey the frequency of stones is increasing. In 1994 in United States stones were diagnosed in only 6,3% of men and 4,1% of women. In 2012 the number of cases of kidney stone raised to 10,6% in men population and 7,1% in women (Scales, 2012). The occurrence of the disease is conditioned by geographical region, race, sex

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and age (Julka, 2010).Women suffer from kidney stones 3-4 times less frequently than men (Herold, 2008). In spite of the fact that the disease is more frequent in men, the ratio of men affected by kidney stones to women has decreased from 3,4 to1,3 (Strope, 2010). The highest prevalence rate was seen in those at age of 50 (Baker, 1993).

DIAGNOSIS AND TREATMENT

Urinary Stones are diagnosed through taking detailed medical history, physical examination, laboratory tests and diagnostic imaging (Bar and Starownik, 2006; and Pearle, 2014). Special consideration is given to eating habits and long term medicines-therapy, especially medicines affecting the reaction of urine such as ephedrine, calcium supplements, vitamines and drugs increasing the risk of stones such as indinavir, triamterene and carbonic anhydrase inhibitors (Mysliwiec and Brzósko, 2005).

Routine general examination and urine culture ought to be carried out. Analyzing the sediment enables identification of crystals and define the chemical composition of the calculi. In case of genetic load and recurrent kidney stones the urine to be tested should be taken from the period of 24 hours prior to the culture test. It is generally recommended to take urine samples twice. On the basis of the daily urine sample diuresis is defined. Urine is determined in terms of pH, excretion of calcium, phosphorus, uric acid, oxalates, trisodium citrate and creatinine (Parks, 1996 and 2002).

Blood is tested to determine calcium concentration, nonorganic phosphate minerals, magnesium, potassium, uric acid, urea and creatinine (Parks, 1996 and 2002). Increased level of uric acid indicates abnormality in purines metabolism. Determining the concentration of calcium in serum helps to diagnose possible primary hyperparathyroidism and hiperkalcemia (Parks, 1996).

When diagnosing kidney stone the crucial role is played by medical imaging (Bochniewicka, 2006). Spiral computed tomography without gadopentetic acid allows detecting small radiolucent urinary calculi invisible in radiography of abdominal cavity. Intravenous urography helps to diagnose small radiolucent calculi that may cause just insignificant urinary retention. Radiography of abdominal cavity is useful and recommended in recognizing calcium stones however, it is not efficient in detecting radiolucent stones. Ultrasonography test should be routinely conducted along with radiography as it allows to estimate the degree of urinary retention, the condition of renal parenchyma and diagnosing the presence of radiolucent stones. Intravenous pyelogram is carried out in case of lack of renal function during urography test and hydronephrosis diagnosed on the basis of ultrasonography test of abdominal cavity (Bar, 2004).

Not only does the choice of optimal treatment and preventing recurrence of the disease depend on the kind of kidney stone but also on proximal tubule transport disturbances (Gadomska-Prokop, 2007). Nutrients contributing to creation of kidney stones are first of all calcium, oxalates, sodium, magnesium, proteins and liquid (Haewook, 2015).

Elaborating dietotherapy aimed at treating kidney stones it is crucial to consider chemical composition of stones in urinary tract and factors we can influence by changing eating habits. These changes will considerably affect composition of urine and as a result will help to prevent recurrence of the disease.

PREVENTION

Acidity of urine as one of lithogenic factors is an important variable that is apparently affected by diet. The key factor for creating urinary calculi is not high excretion of uric acid but low urine pH level below 5,5. Treatment and prophylaxis of this type of stones consists in alkalization of urine to pH 6 level. This result can be obtained by increasing consumption of fruit and vegetables and reducing consumption of sources purines metabolized in system to uric acid. To avoid excessive alkalization that may lead to creation of uric acid crystals which may participate in heterogenic crystallization of calcium oxalate or tricalcium phosphate (Grases, 2006).

Tricalcium phosphate is a compound which is precipitated in alkaline urine and dissolved in acidic. Monitoring pH level is aimed at preventing precipitation of phosphate and dissolving calculi. The priority recommendation is to maximize dilution of urine through increased intake of fluids. Foods containing phosphates have to be eliminated from the diet. It is necessary to reduce consumption of legumes, alkaline mineral waters, potatoes, vegetables, fruit and cheeses. The protein consumption should be equivalent to about 0,8-1 g/kg mc/d (Wahl and Hess, 2000).

The detailed dietary guidelines related to lithogenic factor and type of kidney stone are presented in Table 1.

Table 1: Relation Between Lithogenic Factors in Urine, Type of Kidney Stone and Dietary Recommendations (Grases, 2006)

Lithogenic Factor	Biochemical Parameters of Urine	Kind of Stone	Diet Recommendations
Ph	<5,5	COM,	Reduce consumption of:
		UA,	) Animal protein
		COM/UA,	Increase intake of:
		CYS	) Citrus fruit juices
			) Soft drinks
			) Drinks rich in citric acid
pH	>6	COM,	Reduce:
		COD,	) Vegetarian diet
		HAP,	) Fruit juices
		COD/HAP,	) Soft drinks
		BRU	) Drinks rich in citric acid
Calcium	Women	COD,	Increase consumption of:
	>250 mg/d	HAP,	) Daily fluid intake (> 2 l/d)
	Men	COD/HAP	) Reduce intake of:
	>300 mg/d		) sodium
			) animal protein
			) vitamin C? (2 g/d)
Oxalates	>40 mg/d	COM	Reduce intake of:
			) foods rich in oxalates
			) vitamin C (2g/d)
Citrates	<350 mg/d	COP,	Increase consumption of:
		COM	) foods rich in citrates and drinks rich in citric acid
		COD,	
		HAP	
Phytins	<1 mg/d	COM,	Increase consumption of:
		COD,	) foods rich in phytin
		BRU	
Urates	Women	UA,	Reduce consumption of:
	<600 mg/d	COM/UA	) foods rich in
	Men		) alcohol drinks
	>800 mg/d		

Note: COM – oxalic acid, COD – oxalic acid $C_2H_2O_4$, COD/HAP – oxalic acid $C_2H_2O_4$/hydroksyapatyt, HAP – hydroksyapatyt, STR – struvite, BRU – brushite, UA – uric acid, COM/UA – uric acid/calcium oxalate.

Since it is not always possible to enunciate particular dietary guidelines as there is not always a possibility to analyze the composition of urine, general dietary recommendations have been elaborated to prevent kidney stones.

Accurate recommendations supporting treatment of stones were described by Wahl and Hess (2000) in a so called reasonable diet. According to the authors the key aspect of prophylaxis concerning all types of stones is increase of fluid intake up to 3-4 liters a day which reduces supersaturation of urine (Cheungpasitporn, 2016). As diuresis should be maintained above the level of 2 l/d, it could be assumed that monitoring of excreting urine is more important than monitoring amounts of fluids intake. Liquids ought to be consumed in small amounts through the day after meals and before going to sleep. The intake of fluids should be increased in case of heat and physical effort. It has been proven that consuming less than 1 liter of fluids and producing less than 1 liter of urine per day contributes to creation of calcium stones. Eight-year prospective study conducted by Curhana (2004) proved that the risk of kidney Stones is 32% lower in people consuming 2700 ml of fluids per day than in people consuming less than 1400 ml of fluids per day.

Apart from amount of fluids consumed their quality is an important factor for the risk of lithogenicity. It is highly recommended to drink hypotonic solutions moderately enriched in calcium and magnesium. Wine, beer, coffee, tea and orange juice reduce the risk of calcium stones whereas grapefruit, apple and tomato juices increase the risk (Keble, 2004).

Coffee, in spite of containing oxalate, can be qualified as a drink reducing the risk of stones due to effect of caffeine that increases diuresis. It was found that 240 ml of coffee per day reduces the risk of deposits of calcul by 10% and a glass of tea by 8-14% (Curhan, 1996). Herbal and fruit infusions also limit the risk of stones (Itoh, 2005). A glass of grapefruit juice a day increases the risk of stones even by up to 40% (Curhan, 1998). According to the study 240 ml of beer or wine in everyday diet reduces the risk of stones approximately by 12% in women and 21% in men (Talalaj, 2009). There are no clear results concerning influence of consuming fizzy drinks (Curhan, 1998) and coke drinks (Curhan, 1996; and Passman, 2009).

Meals containing animal protein should be consumed 5-7 times a week but not twice a day. It is recommended to reduce intake of animal proteins to 0,8-1,0 g per kg body weight, which allows reducing calciuria and excreting more citrates with urine (Talalaj, 2009), or replacing it with plant protein.

Reducing consumption of animal protein should be focused on eliminating from diet products containing big amounts of purines (jus, bones residue, giblets, game, lamb, sardines, herring, sprat).

Calcium in diet reduces the risk of calcium stones. In digestive tract it bonds oxalates and inhibits their absorption which results in reducing their concentration in blood and excreting with urine (Brzósko and Myœliwiec, 2009; and Taylor, 2013). Thus, a diet low in calcium is a risk of stones factor, in particular oxalate stones. It was found that consuming not enough amount of calcium contributes to absorption of oxalate and it's excreting with urine. The results of research conducted by Marengo and Romani (2008) indicate that if diet consists of at least 4 g of calcium per day, then even significantly increased amount of oxalate in consumed food does not increase its excreting. People consuming 1000-1300mg of basic calcium per day are the group of the least risk of stones in urine tract (Borghi, 2002; and Stamatelou, 2003).

Thus, it can be concluded that in dietotherapy of kidney stones calcium should not be reduced. Negative calcium balance leads to demineralization of skeletal system, osteoporosis and arterial hypertension. Limiting calcium intake in diet induces secondary hyperoxaluria.

Fruit and vegetables should be consumed at least once a day. However, products with high bioavailability of oxalates such as spinach, rhubarb, beetroot, nuts, chocolate, tea, wheat bran and strawberries should be eliminated as they cause significant increase of concentration of those compounds in urine. Recommended reduction of consumption of foods rich in oxalates is based on conclusion that calcium oxalate is a key factor for creating kidney stones. Reducing consumption of calcium increases absorption of oxalate and its excreting through kidneys whereas higher intake may decrease absorption of oxalates through binding their bigger amounts in intestines. Due to calcium's inhibiting influence on excreting oxalate with urine it is recommended to follow a diet aimed at regulation of calcium balance. The recommended sources of calcium are milk, yoghurt and kefir (Unruh, 2004; and Patchaee, 2009).

The opposite effect is induced by a diet low in calcium, where reduced amount of calcium causes increase of

concentration of free ions of oxalate in intestines to be absorbed. As a result of excessive excretion of oxalates in urine (hyperoxaluria) (Unruh, 2004; and Patchaee, 2009) calcium-oxalate stones may develop, which is a typical uric tract stones in children and adults (Lewandowski and Rodgers, 2004).

Higher consumption of fruit and vegetables resulted in increased intake of fibre, potassium and magnesium. Higher intake of potassium in diet reduces the risk of stones. Potassium prevents development of hyperglycemia that stimulates urethral reabsorption of citrates, substantial inhibitors of crystallization, reducing their concentration in urine (Brzósko and Myœliwiec, 2009). Magnesium, on the other hand, is the inhibitor of increase of calcium phosphate crystals (Rózañski, 2009). The next recommendation for prevention of stones is reducing intake of sucrose and salt. Borghii (2002), Meschi (2004) and Nouvenne (2010) found that excessive intake of sodium chlorium contributes to development of lithogenic processes and proved that high content of sodium in food increases the amount of calcium in urine and every modification of the diet in order to decrease sodium and animal protein intake inhibits developing kidney stones.

Excessive intake of vitamin C, which is metabolized to oxalates, increases concentration of oxalates in urine (Traxer, 2003). Taylor (2004) recommend daily intake of vitamin C below 2 g.

Dietotherapy recommendations were updated by Tiselius (2008), Fink (2013) and Pearle and Skolarikos (2015). The new guidelines concerning treatment and prevention of kidney stone were based on findings concluded from randomized clinical studies and meta-analysis indicated in publications.

When the system does not react to diet modifications it is necessary to support dietotherapy with pharmacological treatment. Application of thiazides is of great importance as they decrease excreting of calcium and additionally has good influence on mineral density of bones (Heilberg, 1997; and Escribani, 2009). As the main side effect of intake of thiazides is hypokalemia that leads to lower excreting of citrates with urine, thiazides ought to be taken along with potassium citrate (Mike, 2006). Allopurinol is also significant in pharmacological treatment as it inhibits production of uric acid in urine.

In terms of prevention of urinary stones careful consideration must be given to natural therapy. Very good results are obtained from drinking herbal infusions (among others Debelizyna, Urostonex, Urosept, Urosan, Rowatinex, Cystone, Fitolizyna, birch and nettle infusions, Uro-up, Zuravit, Furoxin, etc.) as they have anti-inflammatory, antibacterial, diuretic properties and help to relax smooth muscle of urinary trait which enhances excretion of calculi. Crenotherapy, therapy through intake of waters: Jan, Marysieñka, Józef, Wielka Pieniawa, which are supposed to mechanically scour small calculi, affects water and mineral balance and prevent infection of urinary trait.

SUMMARY

In spite of long-term studies on diet in pathogenesis of kidney stones there is no agreement between researchers on which of dietary factors directly contribute to recurrence of urinary stones (Prezioso, 2015). It can be concluded that the most efficient aspect of dietotherapy aimed at prevention of recurrence of urinary stones is reducing consumption of animal protein and salt, high intake of fruit and vegetables, normative intake of calcium and proper rehydration of the system.

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