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Daily habits and kidney stones development rate. Literature review

Paweł Iwańczuk

https://orcid.org/0009-0001-2578-8688

paweliwanczuk@gazeta.pl

USK im. WAM, ul. Żeromskiego 113, 90-549 Łódź

Introduction: Kidney stones disease is a medical condition when hard deposits made of various minerals and substances form inside kidneys. It may lead to clinical symptoms as severe pain felt in the belly area or side of the back. Also it can radiate and reach testicles, groin area, labia. Other symptoms may include blood in the urine, abnormal color of urine, fever, nausea, vomiting. Because of growing incidence rate- adequate question is how can we protect ourselves from kidney stones development by changing habits.

Aim of study: Fundamental aim of study is to demonstrate how daily, routine habits changes may have a huge impact on kidney stones development risk.

State of knowledge: There are a lot of confirmed parameters and factors which can lead to kidney stones development. Factors that increase risk of developing kidney stones include: dehydration, diet (meat intake, fruit/vegetables intake, sodium intake), family or personal history, obesity, digestive diseases and surgery, metabolic disorders, urinary tract infections, anatomical abnormalities- obstruction of the kidney, calyceal diverticulum, horseshoe kidney, ureterocele. This group includes many modified factors, so lifetime risk of kidney stones depends also on our habits and way of life.

Conclusion: There are many modified factors which may lead to this disease and because of that it is crucial to improve patients and whole society awareness about them. By appropriate daily habits changes we can significantly reduce risk of lifetime kidney stone disease development. It is important to know that concrete reports and analyses were made and they demonstrated scientifically proven correlations.

Keywords: kidney stones, urolithiasis, nephrolithiasis, urology

Epidemiology

Kidney stones development is highly prevalent disease. A lifetime risk rate is ranging from 7 to 13% in North America, 5-9% in Europe and 1-5% in Asia (1). In a comparison of NHANES II (1976-1980), NHANES III (1988-1994), NHANES (2007-2010), NHANES (2013-2014) – the conclusion is disturbing and alarming- the incidence rate is getting higher and higher by next reports- NHANES II (3.8%), NHANES III (5.2%), NHANES from period 2007-2010 – 8.8% and finally NHANES from period 2013-2014- 10.1% (2). The highest prevalence was found in male individuals older than 80 years (3). Generally men have a higher prevalence compared with women. It generates a crucial question- what are the reasons of so significant growth of incidence rate. A main branch of reports are attempts to identify as many as it possible underlying factors, which can lead to development of kidney stones, associate and compare it with rising trends of prevalence and incidence all over the world.

Pathophysiology

There are identified some substances that inhibit nucleation, growth, aggregation of crystals (4-5). To the group of inhibitors we classify: citrates, magnesium, pyro phosphate, Tamm-Horsfall protein, urinary prothrombin fragment 1, renal litosthatine, glycosaminoglycans, osteopontin and to the group of promoters of crystallization – calcium, sodium, oxalate, urate. Francisco Spivacow and co- authors aim of the paper was to study the composition and frequency of 8854 patients kidney stones (6). Physicochemical and crystallographic methods were used to assess kidney stone composition. From the total sample 79% of stones were made of calcium salts (oxalate and phosphate), followed by uric acid stones in 16.5%, calcium salts and uric acid in 2%, other salts in 1.9% and cystine in 0.6%. Calcium oxalate favorable circumstances is acidic urine (decreased pH) and for calcium phosphate favorable circumstances is alkaline urine (high pH).

Symptoms and diagnosis

Kidney stones may not lead to clinical symptoms if stones are located still in kidneys and did not move down to ureters. If this condition happens the main symptom is severe pain felt in the belly area or side of the back. Also it can radiate and reach testicles, groin area, labia. Other symptoms may include blood in the urine, abnormal color of urine, fever, nausea, vomiting (8). It is necessary to add that fully developed renal colic is classified as one of the most strong pain, which human can experience, sometimes compared to parturition.

Diagnosis of kidney stones is formulated on the basis of the history of patients, physical examination, urinalysis and imaging features and studies (9). Imaging modalities and techniques are characterized by different sensitivity and specificity rate. CT- 95% sensitivity and 98% specificity and these are the highest values, but it is also associated with bigger radiation exposure than other imaging modalities – 10 mSv. Ultrasonography- 84% sensitivity and 53% specificity and none radiation exposure. KUB (kidney, ureter, bladder radiography)- 57% sensitivity and 76% specificity and 0.7 mSv radiation exposure and MRI- 82% sensitivity and 98% specificity and also none radiation exposure (10).

Treatment

Deirdre M Coll and co-authors checked relationship of spontaneous passage of ureteral calculi to stone size and location as revealed by unenhanced helical CT (11). Over a 29-month period, 850 patients with acute flank pain were evaluated with unenhanced CT. Confirmation of the CT diagnosis was obtained retrospectively for 172 patients with ureteral stones: 115 stones passed spontaneously and 57 required intervention. The spontaneous passage rate for stones 1 mm in diameter was 87%; for stones 2-4 mm, 76%; for stones 5-7 mm, 60%; for stones 7-9 mm, 48%; and for stones larger than 9 mm, 25%. Spontaneous passage rate as a function of stone location was 48% for stones in the proximal ureter, 60% for mid ureteral stones, 75% for distal stones, and 79% for ureterovesical junction stones. If the chance for spontaneous passage of ureteral calculi is estimated as low – there are some surgical and nonsurgical procedures to manage with this disease, which will be described below. Of course- the fundamental for patients is pain management. Administration of NSAID is often not enough and also opioids are recommended to add for patients with more severe pain.

Extracorporeal shock wave lithotripsy (ESWL) is a noninvasive technique for the removal of kidney stones. It uses a lithotripter machine to apply high-intensity pulses of ultrasonic energy. Next used techniques are ureteroscopic surgery and retrograde intrarenal surgery for renal stones (RIRS) (12-14).

Risk factors and our daily habits- how to prevent kidney stones development?

Factors that increase risk of developing kidney stones include: dehydration, diet, family or personal history, obesity, digestive diseases and surgery, metabolic disorders, urinary tract infections, anatomical abnormalities- obstruction of the kidney, calyceal diverticulum, horseshoe kidney, ureterocele (15-18). Some of this factors of course are unmodified, but in this main part of this publication I will focus on risk factors which are associated with our daily habits and follow literature review to answer the question how to prevent kidney stones development and how our behaviors and changes in lifestyle can reduce this risk.

Antonio Nouvenne and co-authors verified effects of a low-salt diet on idiopathic hypercalciuria in calcium-oxalate stone formers (19). It was a 3 months randomized controlled trial. A total of 210 patients were randomly assigned to receive a control diet (n = 102) or a low-sodium diet (n = 108). After 3 months- urinary calcium was within the normal range in 61.9% of the patients on the low-salt diet and in 34.0% of those on the control diet. It shows very bright and clear, that reducing salt in our diet can also reduce urinary calcium level, which is a mineral leading to kidney stones development.

The role of fluid intake in the prevention of kidney stone disease is also considered (20). Chang Xu and co-authors organized a PRISMA- compliant systematic review and dose-response meta-analysis of observational studies about self-fluid management in prevention of kidney stones (21). They conducted a systematic review and dose-response meta-analysis to quantitatively assess the association between fluid intake and kidney stone risk. Based on a literature search of the PubMed, Embase, and Cochrane Library databases, 15 relevant studies (10 cohort and 5 case-control studies) were selected for inclusion in the meta-analysis with 9601 cases and 351,081 total participants. In the dose-response meta-analysis, they found that each 500 mL increase in water intake was associated with a significantly reduced risk of kidney stone formation (relative risk (RR) = 0.93; 95% CI: 0.87, 0.98; $P < 0.01$). It shows how very simple and easy to manage habit is significant in our prevention of kidney stones. It is crucial to communicate every patient that by increasing fluid intake we can reduce their risk of kidney stones recurrence. A bottle of water definitely should become a new friend of everyone who has a high risk of kidney stones development.

Next factor which is confirmed as leading factor of development kidney stones is meat intake. Increased meat intake is strongly associated with kidney stones prevalence. It was a crucial topic of many reports and analysis- especially worth of focusing is Farzaneh Asoudeh and co-authors systematic review and dose- response meta-analysis (22). They searched a literature and included 14 prospective cohorts. A positive association was observed between higher intake of nondairy animal protein (RR: 1.11; 95% CI: 1.03, 1.20; I2 = 0%, n = 4), total meat and meat products (RR: 1.22; 95% CI: 1.09, 1.38; I2 = 13%, n = 3), and processed meat (RR: 1.29; 95% CI: 1.10, 1.51; I2 = 0%, n = 2)

with risk of kidney stones. Reducing meat intake has a lot of advantages and possitive impacts on human health and it is necessary to remember about its influence on reducing kidney stones prevalence.

Next direction of reports which analyse elements of diet habits are fruit and vegetabels dietary intake (23). There are two reports which are especially interesting for us because of large number of people included in. Mathew Sorensen and co-authors included 83.922 postmenopausal women (24). In women with no history of kidney stones higher total dietary fiber (6% to 26% decreased risk, p <0.001), greater fruit intake (12% to 25% decreased risk, p <0.001) and greater vegetable intake (9% to 22% decreased risk, p=0.002) were associated with a decreased risk of incident kidney stone formation in separate adjusted models. In women with a history of stones there were no significant protective effects of fiber, fruit or vegetable intake on the risk of kidney stone recurrence. It shows that increased fruits and vegetable intake may not be enough to prevent recurrence of kidney stone, but it is very crucial element of daily dietary habits among population who did not experienced kidney stones earlier. On the other hand, there is also a prospective cohort study in 502.621 participants from China described by Han Wang which shows different conclusion. Compared with less-than-weekly consumers, the HR (95% CI) for daily fruit consumers was 0.81 (0.75-0.87) (25).

Although main risk factors are associated with dietary habits- also physical activity can change our lifetime risk of kidney stones development (26-27). Xiaojie Feng and co-authors study aimed to determine relationship between physical activity and kidney stones development (28). This study analyzed 8931 adults aged ≥20 years who had participated in the National Health and Nutrition Examination Survey (NHANES) during 2013-16. Kidney stones and physical activity were defined using a standard questionnaire, and metabolic equivalents (MET) were used to quantify the physical activity level. The prevalence of kidney stones decreasing as physical activity increased, reaching a plateau for physical activity at approximately 2480 MET-min week-1 (OR = 0.75, 95% CI = 0.63-0.91).

Obesity is next factor which was considered and nowadays is confirmed as a factor which leads to kidney stones development (29-30). Weinan Chen and co-authors checked association between metabolically healthy obesity and kidney stones (31). Cross-sectional study included 4,287 participants in the National Health and Nutrition Examination Survey from 2011 to 2018. Metabolically healthy obesity individuals (OR: 2.90, 95% CI: 1.18, 7.0) had a significantly higher risk of kidney stones than those with metabolically healthy normal weight. In metabolically healthy participants, a 5% increment in %BF (body fat) was associated with a significantly higher risk of kidney stones (OR: 1.60, 95% CI: 1.20, 2.14).

Summary

Kidney stones development may lead to very severe and difficult to manage symptoms. Analysis show that incidence rate of kidney stones is growing year by year. Because of that kidney stones disease may be considered as included to the group of diseases of civilization. Reports very bright and clear demonstrate that there are a lot of factors associated with daily habits which can reduce risk of kidney stones development. It is crucial, not only for doctors and generally health system providers, but also for patients to identify and be aware of the most important modified factors, because some changes of our lifestyle and behaviour may have a significant impact on reducing kidney stones development.

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Author's contribution:

Conceptualization- Paweł Iwańczuk

Formal analysis- Paweł Iwańczuk

Investigation- Paweł Iwańczuk

Writing- rough preparation- Paweł Iwańczuk

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