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Influence of Coffee, Tea and Drinking Water Source on Calcium Kidney Stone Disease in Universitas Padjdjaran/Hasan Sadikin Hospital Bandung West Java Indonesia: A Case Control Study

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Abstract

The risk of urinary tract stone disease is influenced by lifestyle, genetics and diet. Coffee, tea and drinking water source are one dietary factor that influences the urinary volume and urinary solute concentration. This study investigates the influence of coffee, tea and type of drinking water source to the risk of calcium kidney stone disease in Universitas Padjadjaran/Hasan Sadikin Hospital, Bandung West Java Indonesia. A hospital based case control study was conducted in Universitas Padjadjaran/Hasan Sadikin General Hospital from November 2016 to January 2017. 30 urinary tract calcium disease patients and 30 controlled patients were enrolled in this study. Patient characteristic and number of cup of coffee and tea intake as well as source of water were collected using checklist items. Two tailed independent t-tests Mann Whitney U, Chi square test and Fisher Exact Test were used for statistical analysis. The odds ratios for daily tea and daily tea and coffee intake are 0.33 and 0.2 and are statistically significant ($P = 0.038$ and $P = 0.04$). This result showed that tea and coffee have influence on the risk of calcium stone disease.

Subject Areas

Urology

Keywords

Coffee, Calcium Stone Disease, Risk, Tea, Water

1. Introduction

Urine is a homogenous mixture with 95% water as a solvent and 5% solute [1]. The component of urine solutes can be broadly characterized into inorganic salts, urea, organic compounds, and organic ammonium salts. A review by C. Rose, *et al.* looking at characterization of urine showed that urea is the most predominant constituent making up over 50% of total organic solids, and major solutes excreted in urine are Na, Cl and K [2].

Saturation in a homogenous mixture solution, like urine, depends on the activities of free ion in the solution which is affected by concentration of the ion, pH and combination with other substances. Increase in solute concentration or a decrease in solvent increases the free ionic activity in the solution. When free ion activity increases, the solubility of the solute decrease and the solution becomes oversaturated.

Urine volume and concentration of excreted ion are influenced by dietary factors. An experimental study using eight cats with different sodium and chloride concentration in their diet showed that with higher dietary NaCl concentration, renal Na excretion and urinary volume were increased. This study also showed that although renal Ca excretion increased with higher dietary NaCl concentration, the urinary Ca concentration was constant and urinary oxalate, citrate, P and K concentration were decreased [3].

Coffee, tea and drinking water source influence urinary composition and the risk of kidney stone disease [4] [5]. A prospective analysis from 3 large cohort studies showed that caffein intake is independently associated with a lower risk of kidney stone incident [6]. On the contrary, a cross sectional study analyzing oxalate diet source from 22 stone formers showed that 80% - 85% oxalate in their diet was from regular tea and coffee [7].

The objective of this study is to investigate the influence of coffee, tea and type of drinking water source to the risk of calcium kidney stone disease in Universitas Padjadjaran/Hasan Sadikin Hospital, Bandung West Java Indonesia.

2. Material and Method

This is a hospital based case control study which was conducted in Universitas Padjadjaran/Hasan Sadikin General Hospital from November 2016 to January 2017. Hasan Sadikin General Hospital is a tertiary hospital in Indonesia with one thousand and forty beds and thirty four thousand admissions per year. Ethical permission from Hasan Sadikin general hospital ethical committee was taken before the commencement of the study.

We used Hosmer and Lemeshow formula to calculate sample size which is:

$$n_1 = n_2 = \left(\frac{Z_\alpha \sqrt{2PQ} + Z_\beta \sqrt{P_1 Q_1 + P_2 Q_2}}{P_1 - P_2} \right)^2$$

and found minimal sample for each group are 26 subjects [8]. According to Gay and Diehl at least 30 subjects are required [9]. Thus we used 30 subjects for each group.

Inclusion criteria were hospitalized urinary tract calcium stone disease patients which were confirmed by stone analysis, and age above 18 years old were enrolled in this study. Stone analysis was carried out using qualitative method [10]. Thirty controls that do not have history of stone disease, hormonal disorder and have normal ultrasound urinary tract examination were taken randomly from hospitalized patients. Exclusion criteria patient using chronic calciuretic agent, malignancy that caused hypercalciuria and parathyroid hormone disturbance.

Data collection was carried out using a checklist of items. Data were divided in two sections; patient characteristic and number of cup of coffee and tea intake as well as source of water. Patient characteristic include age, gender, body weight, height, body mass index, education level and diabetes mellitus (DM) comorbidity.

Coffee intake is defined as daily consumption if the person drink one or more cup of coffee in a day and non daily if the person not drinking coffee at least one cup in a day. Tea intake is defined as daily consumption if the person drink one or more cup of tea in a day and non daily if the person not drinking tea at least one cup in a day.

Source of drinking water is defined as bottled water if the water processed by private water company, municipal water if the water processed by the government, and well water if water taken directly from a well. Urine specific gravity were divided into low if it values below normal range (normal range is between 1.005 - 1.030 specific gravity) [11], normal if it values on normal range and high if it values above normal range. Data for urinary pH and stone number (unilateral, bilateral, multiple) are also collected.

For continuous variable two tailed independent t-test was used if the data was normally distributed and Mann Whitney U test if the data was not normally distributed. For categorical variable chi square test was used. If expected count less than 5 was found fewer than 80% of the categories in categorical variable then Fisher Exact Test was used. Statistical analysis was performed using R an open source and freely available statistical computing and graphic.

3. Results

The demographic characteristic for the 30 urinary tract calcium stone disease patients and 30 control subjects are shown in **Table 1**. The subjects predominantly have low education with 63% having an education less than 12 years. Of 30 calcium stone disease patients, 19 (64%) were male and 11 (36%) were female. Of the 30 control subjects, 20 (67%) were male and 10 (33%) were female. The mean age of the urinary tract calcium stone group was 50.6 ± 9.7 years and the mean age of the control group was 55.16 ± 7.3 years. The mean body mass index (BMI) of calcium stone group was 22.8 ± 4.9 and the mean BMI of the control group was 25.5 ± 7.0.

Both groups have similar proportion of diabetes mellitus which were 2 (6.7%) for each group. Urine specific gravity predominantly in normal range value in the two groups.

Table 1. Clinical characteristic of calcium stone disease patients and control subjects.

Characteristic	Patients (N = 30)	Controls (N = 30)	P Value*
Age (Year)	50.6 ± 9.7	55.16 ± 7.3	0.09‡
Gender	Male: 19 (64%) Female: 11 (36%)	Male: 18 (60%) Female: 12 (40%)	0.790
Diabetes Mellitus	2 (6.7%)	2 (6.7%)	1†
Body-Mass Index	22.8 ± 4.9	25.5 ± 7.0	0.097
Urine Specific Gravity	Normal: 24 High: 2 Low: 4	Normal: 27 High: 2 Low: 1	1**

*Unless otherwise noted, two tailed t-test and chi square test were used for comparisons between groups. ‡Mann-Whitney U test were used. †Fisher's exact test was used. **Because assumption for chi square test not met, low urine specific gravity was considered normal and Fisher exact test was used.

Coffee intake was similar in both groups. In the calcium stone group 13 (43%) of subjects have one cup or more coffee daily, while it was also found in 18 (60%) of control subjects ($P = 0.196$). The Odd ratio for coffee consumption was 0.51 (95 percent confidence interval, 0.18 to 1.42).

Daily tea consumption was found in 10 (33%) subjects of calcium stone group and 18 (60%) of control subjects ($P = 0.038$). The odds ratio for tea consumption was 0.33 (95 percent confidence interval, 0.12 to 0.96).

If the subject drinks one cup or more coffee and tea daily the odds ratio was 0.2 and the 95 percent confidence interval were 0.07 to 0.62. There are 7 (23%) subjects in the calcium stone group who drink tea and coffee daily and 18 (60%) in the control group.

The frequency of daily coffee, daily tea, pH and source of water is shown in Table 2.

Mean urinary pH in the calcium stone group was 6.23 and the standard deviation was ± 0.45. While in the control group mean urinary pH was 6.53 with ± 0.68 standard deviation ($P = 0.05$). The most common drinking water source in the calcium stone group was well water which was found in 17 (57%) subjects. In the control group the most common water source was municipal water which is found in 12 (40%) subjects ($P = 0.298$).

4. Discussion

Indonesia as one of the countries that located in Asia stone forming belt region has a diverse cultures, traditions, genetics and diet that may influence the prevalence of urinary tract stone disease [12] [13]. Thalut K, *et al.* reported a bladder stone incidence of 8.3/100,000 population per year in West Sumatera [14]. Data from Sardjito Hospital, a tertiary hospital with 813 bed in Jogjakarta province, showed that there are 58 patients admitted due to urinary tract stone disease in the year 2008 [15]. While in Cipto Mangunkosuma Hospital, a national top referal hospital in Jakarta, it showed that there are 847 patients in the year 2002 [16].

Table 2. Coffee intake, tea intake, urinary pH and source of water in urinary tract stone disease patient and control subjects.

Variable	Patients (N = 30)	Controls (N = 30)	Odds Ratio (95% CI)	*P* Value*
Coffee Consumption	Daily: 13 (43%) Non Daily: 17 (57%)	Daily: 18 (60%) Non Daily: 12 (40%)	0.51 (0.18 - 1.42)	0.196
Tea Consumption	Daily: 10 (33%) Non Daily: 20 (67%)	Daily: 18 (60%) Non Daily: 12 (40%)	0.33 (0.12 - 0.96)	0.038
Coffee and Tea Daily	Daily: 7 (23%) Non Daily: 23 (77%)	Daily: 18 (60%) Non Daily: 12 (40%)	0.2 (0.07 - 0.62)	0.004
Urine pH	6.23 ± 0.45	6.53 ± 0.68	N/A	0.05
Water Source	Bottled Water: 5 (16%) Municipal: 8 (27%) Well: 17 (57%)	Bottled Water: 7 (23%) Municipal: 12 (40%) Well: 11 (37%)	N/A	0.298

CI: confidence interval. *Two tailed t-test and chi square test were used for comparisons between groups.

Our study showed that there are 30 adult patients admitted to our hospital in West Java due to calcium stone disease from November 2016 to January 2017. There were no statistical difference regarding to age, gender, BMI, urine specific gravity, and DM comorbidity between calcium stone group and control group.

Pietro M.F *et al*. prospectively analyzed the association between intake of caffein and incidence of kidney stone in 3 large cohort studies, which are The Health Professional Follow Up Study (HPFS) The Nurse Health Study (NHS I) and second NHS cohort (NHS II). They found that there is an inverse relationship between the risk of kidney stone and caffein intake. The study assigned 95 mg caffein per cup of caffeinated coffee. In their study the upper limit of 95% CI becomes less than one in the 3 large cohort study after a median caffein intake is on the fourth quintile in HPFS, third quintile in NHS I and NHS II (357 mg/day in HPFS, 231 mg/day in NHS I and 165 mg/day in NHS II) which is more than one cup of coffee per day [6].

In our study we defined daily coffee consumption as one or more cup coffee per day and found no statistically significant difference between calcium stone group and control group with $P = 0.196$. The 95% CI however is between 0.18 - 1.42 that showed probably most of the subjects drink only one cup a day in our study. The finding in our study that daily coffee and tea consumption reduce the odds of urinary tract calcium stone more than tea alone (0.2 vs. 0.33) may confirm the probability.

Several studies have showed that tea reduces the risk of urinary tract stone disease [17] [18]. In our study we found the odds ratio of 0.33 witch 95% CI 0.12 - 0.96. The odds ratio and 95% CI is reduce to 0.2 and 0.07 - 0.62 if the subject has a coffee and tea daily which showed an additive effect. This is probably because of increasing amount of caffein intake daily.

Robert L. H. *et al*. investigated a relationship between the sources of municipal water supply and the incidence of urolithiasis in Guam a United States Territory. Their study found that the hospitalization rate for urolithiasis among villages supplied wholly or partially from deep wells was about twice that of villages supplied with municipal water exclusively from a river fed reservoir [19].

An experimental study comparing drinking mineral water containing high bicarbonate (HCO_3) and low bicarbonate showed to patient with multiepisodic urinary stone formation showed that both mineral water increase 24 hours urine volume significantly. In the high bicarbonate group the urinary pH increase significantly compared to controlled group. Supersaturation of calcium oxalate and the risk of uric acid precipitation decrease significantly under high bicarbonate water [20].

In our study we found that well water drinking source is more common in calcium stone group and municipal water source is more common in control group although is not statistically significant. Mineral water is the least common in both groups. The mean urinary pH is lower in the calcium group (6.23 ± 0.45) compared to the mean urinary pH control group (6.53 ± 0.68) but was not statistically significant.

There are several limitations in our study. The first is that we do not have data on volume of urine and volume of water drink per day. We replace the urine volume and volume of water drink per day by urine specific gravity to showed level of hydration in both group and found that both groups are mostly in normal urine specific gravity range value and there are no statistically significant differences between the groups. Secondly we do not have data of type of coffee and type of tea that was consumed by both groups. Lastly we did not measure the excretion of calcium urine and the level of calcium plasma in both groups.

In conclusion a daily tea intake has a lower odds ratio to have calcium stone disease. Adding coffee with tea daily reduces the odds ratio probably because of increase amount of caffeine. A daily tea and daily tea and coffee intake could be recommended to calcium stone former to reduce the likelihood of recurrences.

References

[1] Susan, K.S. and Marjorie, S.D.L (2008) Introduction to Urinanalysis. In: Susan, K.S. and Marjorie, S.D.L., Eds., *Urinalysis and Body Fluids*, 5th Edition, F.A. Davis Company, Philadelphia, 29-31.

[2] Rose, C., *et al.* (2015) The Characterization of Feces and Urine: A Review of the Literature to Inform Advanced Treatment Technology Critical Reviews in Environmental Science and Technology. *Critical Reviews in Environmental Science and Technology*, **45**, 1827-1879. https://doi.org/10.1080/10643389.2014.1000761

[3] Paßlack, N., Burmeier, H., Brenten, T., Neumann, K., Zentek, J. and Vet, J. (2014) Short Term Effects of Increasing Dietary Salt Concentrations on Urine Composition in Healthy Cats. *The Veterinary Journal*, **201**, 401-405. https://doi.org/10.1016/j.tvjl.2014.04.015

[4] Massey, L.K. and Sutton, R.A. (2004) Acute Caffeine Effects on Urine Composition and Calcium Kidney Stone Risk in Calcium Stone Formers. *The Journal of Urology*, **172**, 555-558. https://doi.org/10.1097/01.ju.0000129413.87024.5c

[5] Alyami, F.A. and Rabah, D.M. (2011) Effect of Drinking Parsley Leaf Tea on Urinary Composition and Urinary Stones' Risk Factors. *Saudi Journal of Kidney Diseases and Transplantation*, **22**, 511-514.

[6] Ferraro, P.M., Taylor, E.N., Gambaro, G. and Curhan, G.C. (2014) Caffeine Intake and the Risk of Kidney Stones. *The American Journal of Clinical Nutrition*, **100**, 1596-1603. https://doi.org/10.3945/ajcn.114.089987

[7] Gasińska, A. and Gajewska, D. (2007) Tea and Coffee as the Main Sources of Oxalate in Diets of Patients with Kidney Oxalate Stones. *Roczniki Państwowego Zakładu Higieny*, **58**, 61-67.

[8] Agresti, A. (2007) An Introduction to Categorical Data Analysis. 2nd Edition, John Wiley and Sons, Hoboken, New Jersey. https://doi.org/10.1002/0470114754

[9] Levy, P.S. and Lemeshow, S. (1999) Sampling of Population, Methods and Application. 3rd Edition, John Wiley & Sons, New York.

[10] Delaney, M.P., Price, C.P. and Newman, D.J. (2006) Kidney Disease. In: Burtis, C.A., Ashwood, E.R. and Bruns, D.E., Eds., *Tietz Texbook of Clinical Chemistry*, 4th Edition, W.B. Saunders Company, Philadelphia, 1711-1716.

[11] Williamson, M.A. and Snyder, L.M. (2011) Wallach's Interpretation of Diagnostic Tests. 9th Edition, Lippincott Williams & Wilkins, Philadelphia.

[12] Schefold, R. (1998) The Domestication of Culture: Nation-Building and Ethnic Diversity in Indonesia. *Bijdragen tot de Taal-, Land- en Volkenkunde*, **154**, 259-280. http://www.jstor.org/stable/27865430 https://doi.org/10.1163/22134379-90003898

[13] Abdulla, M.A., *et al*. (2009) HUGO Pan-Asian SNP Consortium, Indian Genome Variation Consortium. Mapping Human Genetic Diversity in Asia. *Science*, **326**, 1541-1545. https://doi.org/10.1126/science.1177074

[14] Thalut, K., Rizal, A., Brockis, J.G., Bowyer, R.C., Taylor, T.A. and Wisniewski, Z.S. (1976) The Endemic Bladder Stones of Indonesia—Epidemiology and Clinical Features. *British Journal of Urology*, **48**, 617-621. https://doi.org/10.1111/j.1464-410X.1976.tb06709.x

[15] Alpendri, A. and Danarto, H.R. (2013) Stone Composition Pattern of Kidney Stone. *Indonesian Journal of Urology*, **20**, 34-36.

[16] Rahardjo, D. and Hamid, R. (2004) Progress on Kidney Stone Management in RSCM from 1997 to 2002. *Jurnal Ilmu Bedah Indonesia*, **32**, 58-63.

[17] Curhan, G.C., Willett, W.C., Speizer, F.E. and Stampfer, M.J. (1998) Beverage Use and Risk for Kidney Stones in Women. *Annals of Internal Medicine*, **128**, 534-540. https://doi.org/10.7326/0003-4819-128-7-199804010-00003

[18] Ferraro, P.M., Taylor, E.N., Gambaro, G. and Curhan, G.C. (2013) Soda and Other Beverages and the Risk of Kidney Stones. *Clinical Journal of the American Society of Nephrology*, **8**, 1389-1395.

[19] Haddock, R.L., Olson, D.R., Backer, L. and Malilay, J. (2016) Urolithiasis, Urinary Cancer, and Home Drinking Water Source in the United States Territory of Guam, 2006-2010. *International Journal of Environmental Research and Public Health*, **13**, 523. https://doi.org/10.3390/ijerph13060523

[20] Karagülle, O., Smorag, U., Candir, F., *et al*. (2007) Clinical Study on the Effect of Mineral Waters Containing Bicarbonate on the Risk of Urinary Stone Formation in Patients with Multiple Episodes of CaO_x-Urolithiasis. *World Journal of Urology*, **25**, 315-323. https://doi.org/10.1007/s00345-007-0144-0