Metabolic syndrome abnormalities and upper urinary tract stone opacity among patients in Kumasi, Ghana

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ABSTRACT

Metabolic syndrome abnormalities such as obesity, hypertension and hyperuricemia are known to promote urinary stone formation. However, the influence of each metabolic syndrome component on stone opacity is unknown. This study describes the associations between hyperuricemia, high blood pressure and obesity with stone opacity in patients with upper tract urolithiasis in Kumasi, Ghana. We prospectively analyzed all patients treated for upper tract urolithiasis at the Bomso Specialist Hospital in Kumasi from January 1 2014, to December 31, 2017. The patients had plain radiograph (KUB X-ray) of the abdomen and pelvis for stone opacity and demographic data such as age and sex, weight, height and blood pressure readings recorded. Serum uric acid, urea, creatinine and electrolytes were measured. We calculated the body mass index (BMI) and used chi-square test to determine the associations between BMI, serum uric acid and blood pressure, with urinary tract stone opacity. A p-value of less than 0.05 was considered significant. There were 135 patients with upper tract urinary stones who also had KUB X-ray for the opacity of stone. This included 78(57.8%) males and 57(42.2%) females with a mean age of 42.5 years. There were 130 (96.3%) patients with radiopaque stones and 5 (3.7%) with radiolucent stones. The majority 73 (54.1%) were obese, 84(62.2%) had normal blood pressure and 119 (88.1%) had normal serum uric acid levels. Hyperuricemia was associated with stone opacity (p= 0.047) but there was no statistically significant association between obesity (p=0.236), hypertension (p=0.917) and opacity of stone. Serum uric acid is significantly associated with stone opacity but not hypertension or obesity.

Key words: Hyperuricemia, blood pressure, obesity, opacity, metabolic syndrome.

INTRODUCTION

The opacity of urinary tract stone is useful in stone diagnosis, treatment and in the selection of appropriate imaging during follow-up (Güçük and Üyetürk, 2014). Stone opacity influences the outcome of treatment modalities such as extracorporeal shockwave lithotripsy (ESWL) and percutaneous nephrolithotomy (Cimentepe et al., 2003). The use of fluoroscopy in detecting residual stones, for example, is dependent on the opacity of the stones. It is known that metabolic syndrome abnormalities such as obesity, hypertension and hyperuricemia promote urinary stone formation (https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1442-2042.2012.03131.x; Bramono et al., 2015).

These abnormalities decrease urinary citrate and PH and increase uric acid and calcium excretion, leading to increased risks of uric acid and calcium stone formation (Jeong et al., 2011; Sakhaee and Maalouf, 2008). However, the influence of each metabolic syndrome component on stone composition and whether they form calcium stones, uric acid stones or both is unknown (https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1442-2042.2012.03131.x; Daudon et al., 2006). It is known that calcium containing stones are likely to be radiopaque whilst
Table 1: Clinical characteristics of patients according to urinary stone opacity.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Radiopaque stone n =130 (% of patients with radiopaque stones within parameter)</th>
<th>Radiolucent stone n=5 (% of patients with radiolucent stones within parameter)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperuricemia</td>
<td>14(87.5%)</td>
<td>2(12.5%)</td>
<td>16(11.9%)</td>
</tr>
<tr>
<td>Normal serum uric acid levels</td>
<td>116(97.5%)</td>
<td>3(2.5%)</td>
<td>119(88.1%)</td>
</tr>
<tr>
<td>Obese</td>
<td>69 (94.5%)</td>
<td>4(5.5%)</td>
<td>73(54.1%)</td>
</tr>
<tr>
<td>Non obese</td>
<td>61(98.4%)</td>
<td>1(1.6%)</td>
<td>62(45.9%)</td>
</tr>
<tr>
<td>Elevated blood pressure</td>
<td>49(96.1%)</td>
<td>2(3.9%)</td>
<td>51(37.8%)</td>
</tr>
<tr>
<td>Normal blood pressure</td>
<td>81(96.4%)</td>
<td>3(3.6%)</td>
<td>84(62.2%)</td>
</tr>
</tbody>
</table>

Table 2: Risk estimation of stone opacity in urinary tract stone patients.

<table>
<thead>
<tr>
<th></th>
<th>Radio-opaque stones</th>
<th>Radiolucent stones</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-value</td>
<td>OR(95% CI)</td>
</tr>
<tr>
<td>Hyperuricemia</td>
<td>0.047</td>
<td>1.114(0.924-1.344)</td>
</tr>
<tr>
<td>Obesity</td>
<td>0.236</td>
<td>1.041(0.977-1.109)</td>
</tr>
<tr>
<td>Elevated blood pressure</td>
<td>0.917</td>
<td>1.004(0.937-1.075)</td>
</tr>
</tbody>
</table>

uric acid containing stones are usually radiolucent (EAU-Guidelines-Urolithiasis-2015-v2.pdf).

This study therefore was conducted to describe the associations between these metabolic syndrome abnormalities with stone opacity in patients with upper tract urolithiasis in Kumasi, Ghana. The authors set out to determine whether stone patients with hyperuricemia, high blood pressure or obesity formed either radiopaque or radiolucent stones.

METHODS

We prospectively analyzed all patients treated for upper tract urolithiasis at the Bomso Specialist Hospital in Kumasi from January 1 2014, to December 31, 2017. The patients had plain radiograph (KUB X-ray) of the abdomen and pelvis for stone opacity in addition to ultrasound scans or computer tomography (CT scan) for other stone characteristics such as number, size and location of stones. In addition to basic demographic data such as age and sex, all patients had their weight, height, blood pressure readings recorded. All patients underwent biochemical analysis of their serum for the levels of uric acid, electrolytes such as calcium, magnesium, phosphate, urea and creatinine levels.

We calculated the body mass index (BMI) using patients weight and height and categorized them into obese (BMI >30kg/m²) or non-obese (BMI < 30 kg/m²). Patients with systolic blood pressure > 120 mmHg or diastolic blood pressure >80 mmHg were considered to have elevated blood pressure and all patients with serum uric acid levels > 6.8 mg/dl were considered to have hyperuricemia.

Data were analyzed with PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc. A p-value was calculated using chi-square test. Chi-square analysis was used to determine the odds ratio (OR) and 95% confidence interval (CI) of associations between BMI, serum uric acid and blood pressure, with urinary tract stone opacity. A p-value of less than 0.05 was considered statistically significant.

Informed consent was obtained from all patients and ethical clearance for the study was obtained from the Committee on Human Research Publication and Ethics of the Kwame Nkrumah University of Science and Technology.

RESULTS

One hundred and seventy (170) patients with upper tract urinary stones were seen over the study period but only 135 underwent KUB-X ray for the opacity of stone. This included 78(57.8%) males and 57(42.2%) females with a mean age of 42.5 years. There were 130 (96.3%) patients with radiopaque stones and 5 (3.7%) with radiolucent stones on plain radiography. The majority 73 (54.1%) of the patients were obese, 84 (62.2%) of them had normal blood pressure and 119 (88.1%) of them had normal serum uric acid levels. The relationship between these clinical characteristics and stone opacity is shown in Table 1 and the risk of stone opacity is shown in Table 2. As shown in Table 2, hyperuricemia was associated with stone opacity (p= 0.047) but there was no statistically significant association between obesity (p=0.236), hypertension (p=0.917) and opacity of stone. The probability of forming a
radiolucent stone with hyperuricemia is 0.13.

DISCUSSION

The purpose of this study was to determine the association between metabolic syndrome components and stone opacity in urinary calculi patients. Obesity and high blood pressure showed no statistically significant association with stone opacity whilst elevated serum uric acid levels showed significant association with stone opacity. This is similar to the observation in Indonesia that high BMI and high blood pressure had no statistically significant association with stone opacity (Bramono et al., 2015). However, contrary to our findings, they observed no significant association between serum uric acid levels and stone opacity.

Hyperuricemic patients tend to form uric acid stones and similar to our findings, other studies found an association between hyperuricemia and radiolucent stone formation (Strohmaier et al., 2012; Haffner et al., 1996).

However, calcium oxalate stones which are radiopaque can also form by a salting-out mechanism in a hyperuricosuric environment. Jeong, et al. (2011) found that hyperuricosuria was associated with both uric acid stone formation and calcium oxalate stone formation. This probably explains why contrary to the findings in this study, Bramono et al. (2015) in Indonesia found no significant association between serum uric acid levels and stone opacity.

Obesity alters the citrate, phosphate, oxalate, and uric acid levels of serum and urine and is associated with acidic urine. The acidic urine associated with obesity is probably due to insulin resistance in the renal proximal tubule, leading to defective ammonium excretion and thus lowering urinary pH (Maalouf et al., 2004). A low urinary pH (≤5.5) is known to promote uric acid stone formation (Pak et al., 2001).

Obesity is also significantly associated with calcium oxalate stone formation. This could be due to high dietary intake of calcium and oxalate in obese people or could be due to the fact that the acidic urine leads to decreased production of calcium phosphate crystals, resulting in a relative increase in the formation of calcium oxalate stones (Chou et al., 2011).

Obesity can, therefore, be associated with increased risk of forming both uric acid stones which are radiolucent and calcium oxalate stones which are radiopaque. This probably explains why obesity was not found in this study to have any statistically significant risk of selectively forming either radiopaque stones or radiolucent stones.

It's been found that patients with high blood pressure, tend to have radiopaque stones rather than radiolucent stones (Bramono et al., 2018). However, in this study, we found no significant relationship between blood pressure and stone opacity.

Borghi et al. (1999) found that in hypertensive patients, urinary factors for stone formation were supersaturation of calcium oxalate for calcium stones and uric acid super saturation for uric acid stones. Hence, hypertensive patients form calcium oxalate stones which are radiopaque or uric acid stones which are radiolucent and as observed in this study, do not show any statistically significant association with either radiolucent or radiopaque stones formation.

In fact, diet-induced hyperuricemia is suspected to be the underlying etiology of hypertension in the majority of hypertensive patients and studies have confirmed the association of hyperuricemia with endothelial dysfunction and increased vascular angiotensin II activity resulting in elevated blood pressures (Haffner et al., 1996; Johnson et al., 2005; Perlstein et al., 2004).

This study is limited by the small numbers of patients with radiolucent stones. A further study with a larger sample size may be useful to confirm our findings.

CONCLUSION

Serum uric acid is significantly associated with stone opacity but not hypertension or obesity.

REFERENCES


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