Chemical Composition of Urinary Tract Stones: Experience at a Referral Center of Khyber Pakhtunkhwa Province

Objective: To find out the chemical composition of urinary tract stones in patients attending our institute.

Study Design: Descriptive case series study

Place and Duration: This study was conducted at Institute of Kidney diseases (IKD), Peshawar from May 2009 to December 2010.

Materials and Methods: The study included all patients of either gender and all ages who were diagnosed to have urinary tract stones and were managed at our centre. Patients who did not consent to participate in the study were excluded. Chemical analysis of stones was performed on stones passed spontaneously, stone/fragment/gravel passed after ESWL or stone/fragments retrieved after endourological intervention or open surgery. Results were reviewed and analyzed with the help of SPSS 11.

Results: Out of 138 patients, 105 were male (76.1%) and 33 (23.9%) were female. Pure calcium oxalate calculi were found in 53 cases (38.4%). Pure uric acid calculi were found in 13 cases (9.4%). Calcium oxalate mixed with uric acid was found in 29 cases (21%). 24 Patients were having Magnesium ammonium Phosphate stones (17.4%). Stones containing both Calcium Oxalate and Calcium Phosphate were present in 16 patients (11.6%). Three patients (2.2%) were having stones containing Calcium Oxalate, Calcium Phosphate and Uric acid.

Conclusion: Calcium containing mixed stones constitute the commonest variety of urinary tract calculi in our local population of Khyber Pakhtunkhwa Province.

Key words: Renal calculus, Chemical composition, Calcium oxalate, Uric acid, Magnesium ammonium phosphate.

Introduction

The history of urinary tract stones dates back to antiquity. The earliest records of such stones trace back to the Egyptian mummies in 4400 BC. Globally 1%–15% of the population is affected by urinary tract stones. These constitute the third most common cause of urinary tract disease following urinary tract infections and prostatic afflictions.  

The chemical constituents of urinary calculi were first determined with uric acid stones and were called the acid of calculus. Urinary stones are polycrystalline aggregates consisting of varying amounts of crystal and organic matrix components. Calcium oxalate, calcium phosphate (apatite), uric acid, struvite (magnesium ammonium phosphate), and cystine are the most common urinary stone types. There is a very broad variety in appearance, color, and consistency of the different urinary stones. Calcium Oxalate stones usually have a dark-brown or black color. The surface is often mulberry-like. The stones are very hard. Apatite stones have a white or gray color. The surface is mostly smooth, and the consistency ranges from solid to loose. Struvite often forms with apatite mixed stones in the form of big staghorn stones. The color is mostly white to light gray. In most cases, they have a loose consistency. The color of stones of uric acid and uric acid dehydrate varies from light yellow via red-yellow to red brown. Their surfaces are mostly very smooth. Stones of cystine have a typical yellow color and a wax-like surface. The consistency is very solid.  

Stone analysis could be chemical or physical. The various methods employed for analysis include chemical analysis, thermal analysis, electron diffraction,
scanning electron microscopy, electron microprobe, Laser microprobe, X-ray microcradiograph, polarization microscopy, Infrared spectroscopy, X-ray diffraction. The crystalline composition of a stone reflects the urine chemistry and abnormalities in tubular physiology during the process of stone development. Generally the 5 years recurrence rate is 50% in patients without prophylactic intervention.

The present study was undertaken to find out the chemical composition of urinary tract stones in patients attending our institute.

**Materials and Methods**

This descriptive case series study was conducted at Institute of Kidney diseases (IKD), Peshawar from May 2009 to December 2010. Convenience Sampling technique was employed. The study included patients of either gender and all ages who were diagnosed with urinary tract stones. Patients who did not consent to participate in the study were excluded. Chemical analysis was performed on renal stones passed spontaneously, stone/fragment/gravel passed after ESWL or stone/fragments retrieved after open surgery or endourological procedure. The stones after removal were sent to laboratory for chemical analysis. The samples were washed with deionized water and dried in air. The stone powder was obtained by pulverizing it in an agate mortar. Qualitative analysis of this powder was done for various substances by treating the powder with the chemical agents provided by the chemical kit (Merck) for the diagnosis of various types of chemical stones. Results were analyzed with the help of SPSS 11.

**Results**

Out of 138 patients, 105 were male (76.1%) and 33 (23.9%) were female. Majority of the patients (49.2%) belonged to the in age group 31 – 60 years. (Table I). 47.8% stones were from kidney, 37% were from ureter and 15.2% from were urinary bladder(Table II).

Pure calcium oxalate calculi were found in 53 patients (38.4%). Pure uric acid calculi were in found 13 cases (9.4%). Calcium oxalate mixed with uric acid was found in 29 cases (21%). 24 Patients were having Magnesium ammonium Phosphate stones (17.4%). Stones containing both Calcium Oxalate and Calcium Phosphate were present in 16 patients (11.6%). Three patients (2.2%) were having stones containing Calcium Oxalate, Calcium Phosphate and Uric acid (Table III).

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Total Number</th>
<th>% of Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Oxalate</td>
<td>53</td>
<td>38.4%</td>
</tr>
<tr>
<td>Calcium Oxalate + Uric Acid</td>
<td>29</td>
<td>21%</td>
</tr>
<tr>
<td>Magnesium Ammonium Phosphate</td>
<td>24</td>
<td>17.4%</td>
</tr>
<tr>
<td>Calcium Oxalate + Calcium Phosphate</td>
<td>16</td>
<td>11.6%</td>
</tr>
<tr>
<td>Calcium Oxalate + Uric Acid</td>
<td>13</td>
<td>9.4%</td>
</tr>
<tr>
<td>Calcium Oxalate + Calcium Phosphate + Uric Acid</td>
<td>3</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

**Discussion**

Many intrinsic and extrinsic factors contribute to the formation of urinary tract stones. Urine is a complex solution and its pH changes frequently. Super saturation of urine induces crystallization which leads to the formation of urinary stones The presence of multiple inorganic and organic constituents and interactions between promoters and inhibitors, all modulate pathogenesis of stone formation. Crystalline material is nucleted somewhere inside the nephron that flow toward collecting ducts and serve as nidi for stone formation These particles grow into the size range of, or even greater than, the inner diameter of the collecting ducts via crystal aggregation. These particles will have chance to grow into clinically significant stones, which may be unable to pass through the urinary tract in a spontaneous fashion. In our study the majority of patients with urinary tract stones belonged to the age group 31060 years. These results conform with those of Tassadaqul et al who reported kidney stones to be more prevalent in mature patients of age group 13- 50 years. Rahman et al observed that peak age of occurrence of renal stones was 38 years. According to Channa et al highest incidence of renal stones was found in age group 30 to 44. Durgawale et al reported higher incidence in age...
group 30 to 60 years. Risal et al reported high prevalence of urinary stones in 20 years age group.

In our study the stones were frequent among males than females. This finding conforms with what is reported by Tassaduq et al who found that 74.14% patients were male and 25.86% were female. According to Djelloul et al the male to female ratio was 2.23 in his study. Mshelial et al reported that urinary stones were 12 times more common in males as compared to females. In males, androgens play an important role in stone formation by increasing urinary oxalate excretion and deposition of calcium oxalate in the kidney while in females, estrogens do the opposite job.3

In our study calculi occurred more in upper part of the urinary tract (47.8% in kidney and 37% in ureter) than the lower tract (15.2% in bladder). Mshelial in Maiduguri, Nigeria conducted a study in which he observed 70.9% stones in upper tract and 29.1% in lower urinary tract.18 In another study, conducted by Durgawale et al 51.2% stones were from upper renal tract and remaining from lower tract.

In our study calcium containing stones were the commonest variety of stones. The risk factors for calcium stone formation vary. These may be hypercalcemia, hyperparathyroidism, renal tubular acidosis, hypocitruria. Hyperoxaluria can be caused by oxalate containing foods (tea, spinach, nuts, pepper and beet) or the excess absorption of oxalate due to various gut diseases (biliary diseases, bacterial overgrowth syndrome or chronic pancreatitis) or ileojejunal surgery.8 The formation of mixed stones has a multifactorial etiology. Magnesium ammonium phosphate (17.4%) predicts the presence of bacteriuria and urinary tract infections caused by urea splitting bacteria (Proteus sp, Klebsiella sp). Magnesium ammonium phosphate (17.4%) predicts the presence of bacteriuria and urinary tract infections caused by urea splitting bacteria (Proteus sp, Klebsiella sp).5,6,8 The calculus must be treated as infected foreign body and removed as early as possible.6

In our study uric acid stones accounted for 9.4% of the total stones. The various factors that contribute to formation of these stones included hyperuricosuria, gout, excess intake of vitamin D, urinary tract infections and blockage of urinary tract.5 Due to increased non vegetarian diet, the uric acid content of body increases causing risk of hyperuricosuria and further formation of urate stones.7 Farooq et al in their 125 stones analysis in Rahim Yar Khan showed calcium oxalate was frequent salt found (93.6%). Phosphate was present in 11.2% and urate was present in 6.4% stones. Urinary biochemical profile of patients with renal calculi in Multan also reported predominance of calcium oxalates +uric acid in their stone analysis study.9 A study, conducted by Hashmi et a in D I Khan reported calcium oxalate as the most common stone (60%). Rahman et al observed that calcium is present in 92 % calculi. E. Choo-Kang from West Indies also reported that calcium was the main constituent, being seen in 93.9% of stones3. In another study form Multan, Rafique et al reported uric acid calculi to be at the top with 28%, followed by CaOX calculi 26%, CaOX+calcium phosphate 10% and CaOX+calcium phosphate+uric acid 7%. Percentages of uric acid stones encountered vary from 1-26% and calcium oxalate from 65-88% in various parts of world.15 Rab et al conducted a study in Peshawar. Of 188 stones analyzed, 109 (58%) were pure calcium oxalate stones and in 177 (94%) calcium oxalate was the main component.

In our study we did not find the very rare types of stones.

Of the less common stone varieties, struvite stones are commonly associated with urinary tract infections, most notably secondary to urea splitting organisms such as Proteus and Klebsiella.6,8 Cystine stones are a rare form associated with inborn errors of metabolism resulting in abnormal absorption of dibasic amino acids in the small bowel and proximal renal tubule.8,9 Knowledge of the chemical composition of urinary stones helps in understanding their etiology, adequate management including prevention and recurrence. Hence such compositional studies should be regularly conducted. Further studies are suggested to confirm and improve upon our results.

**Conclusion**

Calcium containing mixed stones constitute the commonest variety of urinary tract calculi in our local population of Khyber Pakhtunkhwa Province.

**References**


