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EXPLORING THE RELATIONSHIP BETWEEN URINARY TRACT INFECTION AND METABOLIC DISEASES IN PATIENTS WITH URINARY STONES

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Abstract

Background: Urinary Tract Infection (UTI) and metabolic diseases significantly impact global health, with urinary stones being influenced by various factors, including metabolic abnormalities.

Objective: This study's main goal was to find out how common urinary tract infections are in the area of Pakistan and how they interact with metabolic disorders in those who have kidney stones.

Methodology: The research was conducted from January to December 2022 at the medicine department of Saidu Group of Teaching Hospital, Swat, Pakistan, using a retrospective cohort approach. Retrospective reviews of medical records were used to gather data, such as the history of metabolic diseases, the composition of stones, and UTI episodes. Urine samples collected every 24 hours and blood analysis were among the laboratory procedures carried out. Using SPSS for statistical analysis, a significance threshold of $p < 0.05$ was established.

Results: The research, which included 162 individuals with kidney stones, revealed a gender distribution that was well balanced, with 48.14% (n = 78) men and 51.86% (n = 84) women. Urinary stone history (n=58; 35.80%), diabetes mellitus (n=47; 29.01%), hypercalciuria (39; 24.07%), and past UTIs (n-95; 58.64%) were also significantly prevalent in the clinical history. A strong correlation was seen between metabolic abnormalities, namely hypercalciuria, and UTI ($p = 0.001$). A significant correlation between UTI and hypercalciuria was shown by logistic regression analysis (OR: 3.87, $p = 0.0002$). There was a noteworthy correlation seen in stone composition, namely in calcium oxalate (OR: 1.89, $p = 0.062$).

Conclusion: The research highlights a noteworthy occurrence of urinary tract infections, metabolic disorders, and repeated instances of bladder stones in individuals diagnosed with urinary stones.

Keywords: Urinary Tract Infection, Metabolic Diseases, Urinary Stones, Pakistan

Introduction

Urinary Tract Infection (UTI) and metabolic diseases represent significant health challenges worldwide, with considerable implications for the affected individuals and healthcare systems [1,2]. Metabolic disorders are one of the many variables that might impact the complicated process of stone development inside the urinary tract [3]. Crystalline objects that develop in the kidneys or other urinary system organs are called urinary tract stones, often referred to as kidney stones or renal calculi [4]. Urinary stone prevalence has been continuously increasing, which has led to higher rates of morbidity and higher worldwide healthcare costs [5]. Although the relationship between metabolic illnesses and the development of stones has been established, little is known about the relationship between urinary tract infections and metabolic problems in stone patients [6].

One typical consequence in people with urinary stones is urinary tract infection, which is brought on by bacterial invasion of the urinary system [7]. The diagnosis and treatment of UTIs and stone formation present special difficulties that often call for a multidisciplinary approach [8]. Urinary stones have been related to metabolic illnesses, such as hypercalciuria and diabetes mellitus, amongst others. These circumstances may change the content of urine, which may encourage mineral crystallization and the eventual development of stones [9]. For the purpose of creating focused treatment plans and preventative measures, it is essential to comprehend the complex relationships that exist between metabolic disorders and UTI in stone patients [10].

The coexistence of UTI and metabolic disorders is a significant worldwide health problem, with a special emphasis on the presence of urinary stones in Pakistan [11]. Urinary stone development is more common in Pakistan due to a combination of environmental variables, genetic susceptibility, and dietary patterns [12]. Given the high prevalence of metabolic disorders such as diabetes mellitus in the nation, it is critical for policymakers and healthcare professionals to comprehend how these ailments interact with UTI in stone patients [13].

One important factor that needs further research is how often UTIs are among Pakistani stone patients [14]. Few studies have looked at the unique microbial compositions and patterns of antibiotic resistance in UTIs that coexist with urinary stones in this cohort. In order to close this information gap, this research examines the epidemiology of urinary tract infections (UTIs) among patients with urinary stones in Pakistan, taking into account geographical differences and their effects on clinical outcomes.

Objective

This study's main goal was to find out how common urinary tract infections are in the area of Pakistan and how they interact with metabolic disorders in those who have kidney stones.

Methodology

Study Design

This research adopts a retrospective cohort study design conducted at Saidu Group of Teaching Hospital, Swat, Pakistan, spanning from January to December 2022. Because of its thorough design, medical data may be examined to provide light on how metabolic disorders and urinary tract infections (UTI) interact in individuals who have urinary stones.

Ethical Approval

The research was granted ethical clearance by the Institutional Review Board (IRB). This ensures that ethical standards are followed and that the participants' rights and welfare are protected.

Sample Size
A total of 162 patients were involved in the research; they were chosen according to certain standards to provide a representative sample for thorough examination.

Inclusion Criteria
The research focused on a complete approach to stone detection by enrolling individuals who had been diagnosed with urinary stones based on either radiological or laboratory evidence. Furthermore, those having a history of urinary tract infections (UTIs) were included.

Exclusion Criteria
Individuals who had previously had urinary stones or a UTI outside of the designated window were also disqualified. Furthermore, instances with illnesses or comorbidities that would make it more difficult to interpret the results were not taken into account.

Data Collection
Medical records of eligible patients were retrospectively reviewed, and relevant data were extracted. Information regarding UTI episodes, stone composition, metabolic disease history (e.g., diabetes mellitus, hypercalciuria), demographic details, and treatment modalities were systematically collected using a standardized data collection form.

Laboratory Tests
Urine samples were taken every 24 hours for each patient, and the following parameters were analyzed: pH, specific gravity, creatinine, uric acid, calcium, phosphate, oxalate, citrate, and magnesium. Serum levels of urea, creatinine, uric acid, phosphate, and calcium were also measured in blood samples.

Statistical Analysis
Statistical analysis was conducted to explore the relationship between urinary tract infection (UTI) and metabolic diseases in patients diagnosed with urinary stones. Descriptive statistics summarized demographic features, stone composition, and metabolic disease prevalence. Categorical variables were expressed as frequencies, and continuous variables as means or medians. Chi-square and t-tests assessed associations. Logistic regression analyzed UTI's odds ratios for specific metabolic diseases, considering confounding factors. Subgroup analyses explored variations based on stone composition and demographics. Significance was set at $p < 0.05$, using SPSS (27.0), with results interpreted clinically and statistically.

Results
In our study, 162 participants with urinary stones were observed. The gender distribution showed that there were about equal numbers of men (n = 78; 48.14%) and women (n = 84; 51.86%), with a range of age groups (n = 45; 27.78%), 31–45 years (n = 61; 37.66%), and 46–55 years (n = 56; 34.56%). The bulk of participants (n = 120; 74.07%) were from Peshawar. The ethnic composition of the participants was as follows: Punjabi (n = 35; 21.60%), Sindhi (n = 20; 12.35%), Pashtun (n = 80; 49.39%), Baloch (n = 12; 7.40%), and others (n = 15; 9.26%). Regarding occupation, 37.03% (n=60) had a job, 17.91% (n=29) were jobless, 25.93% (n=42) were students, and 19.13% (n=31) worked in another capacity. The individuals' educational backgrounds differed; 17.28% (n=28) only completed high school, 38.89% (n=63) went to college, and 43.83% (n=71) attended university. The clinical history demonstrated a noteworthy occurrence of prior urinary tract infections (n=95; 58.64%), urinary stones (n=58; 35.80%), and metabolic disorders (n=47; 29.01%) and hypercalciuria (n=39; 24.07%). Radiological evidence was found in 67.90% of the stones (n=110), laboratory evidence was found in 32.10% of the stones (n=52), and stone composition analysis identified 59.87% of the stones (n=97). The majority of treatment options (n = 131; 80.86%) comprised medicine, while 19.14% (n = 31) chose surgery (table 1).

Table 1: Demographic Profile of Participants: Gender, Age, Geographic Location, Ethnicity, Occupation, and Education Level

Demographic Characteristic	Total Participants (N=162)	Percentage (%)	P-value
Gender Distribution			
Male	78	48.14	0.637
Female	84	51.86	
Age Distribution			
15-30 years	45	27.78	0.289
31-45 years	61	37.66	
46-55 years	56	34.56	
Geographic Location			
Peshawar	120	74.07	0.000
Other	42	25.93	
Ethnicity			
Punjabi	35	21.60	0.000
Sindhi	20	12.35	
Pashtun	80	49.39	
Baloch	12	7.40	
Other	15	9.26	
Occupation			
Employed	60	37.03	0.001
Unemployed	29	17.91	
Student	42	25.93	
Other	31	19.13	
Education Level			
High School	28	17.28	0.001
College	63	38.89	
University	71	43.83	
Clinical History			
Previous UTI	95	58.64	<0.001
Previous urinary stones	58	35.80	
History of metabolic diseases			
Diabetes Mellitus	47	29.01	0.001
Hypercalciuria	39	24.07	
Hyperoxaluria	26	16.04	
Cystinuria	19	11.72	
Hyperuricosuria	14	8.64	
Other	18	11.11	
Stone Characteristics			
Radiological evidence	110	67.90	0.000
Laboratory evidence	52	32.10	
Stone composition	97	59.87	
Treatment Modalities			
Medication	131	80.86	0.002
Surgery	31	19.14	

Among the participants, 61 (37.65%) had urinary bladder stones (recurrent stones), and 101 (62.35%) did not (table 2). The presenting complaints varied, with 42 (25.92%) reporting hematuria, 23 (14.20%) experiencing burning micturition, and 97 (59.88%) presenting with lumbar pain. Diagnoses included 104 (64.20%) with renal stones, 37 (22.84%) with ureteric stones, and 21 (12.96%) with both renal and ureteric stones. A family history of urolithiasis was reported by 109 (67.28%) participants. Stone composition analysis revealed varying compositions, including calcium phosphate (n=7; 4.32%), calcium oxalate (n=133; 82.10%), struvite (n=1; 0.62%), cystine (n=3; 1.85%), and uric acid (n=18; 11.11%).

Table 2: Clinical Characteristics and Stone Composition: UTI History, Stone Characteristics, and Treatment Modalities

Variables	Total Participants (N=162)	Percentage (%)
Urinary bladder stone (Recurrent stone)		
Yes	61	37.65
No	101	62.35
Presenting complaint		
Hematuria	42	25.92
Burning micturition	23	14.20
Lumber pain	97	59.88
Diagnosis		
Renal stone	104	64.20
Ureteric stone	37	22.84
Renal + ureteric stone	21	12.96
Family history of urolithiasis		
Yes	109	67.28
No	53	32.72
Stone composition on stone analysis		
Calcium phosphate	7	4.32
Calcium oxalate	133	82.10
Struvite	1	0.62
Cystine	3	1.85
Uric acid	18	11.11

The prevalence of metabolic abnormalities included hypercalcemia (n=9; 5.56%), hyperphosphaturia (n=24; 14.81%), hyperuricosuria (n=8; 4.94%), hypocitraturia (n=15; 9.26%), hypercalciuria (n=41; 25.31%), hypernatriuria (n=33; 20.37%), hypomagnesuria (n=13; 8.02%), and hyperoxaluria (n=19; 11.73%) (figure 1).

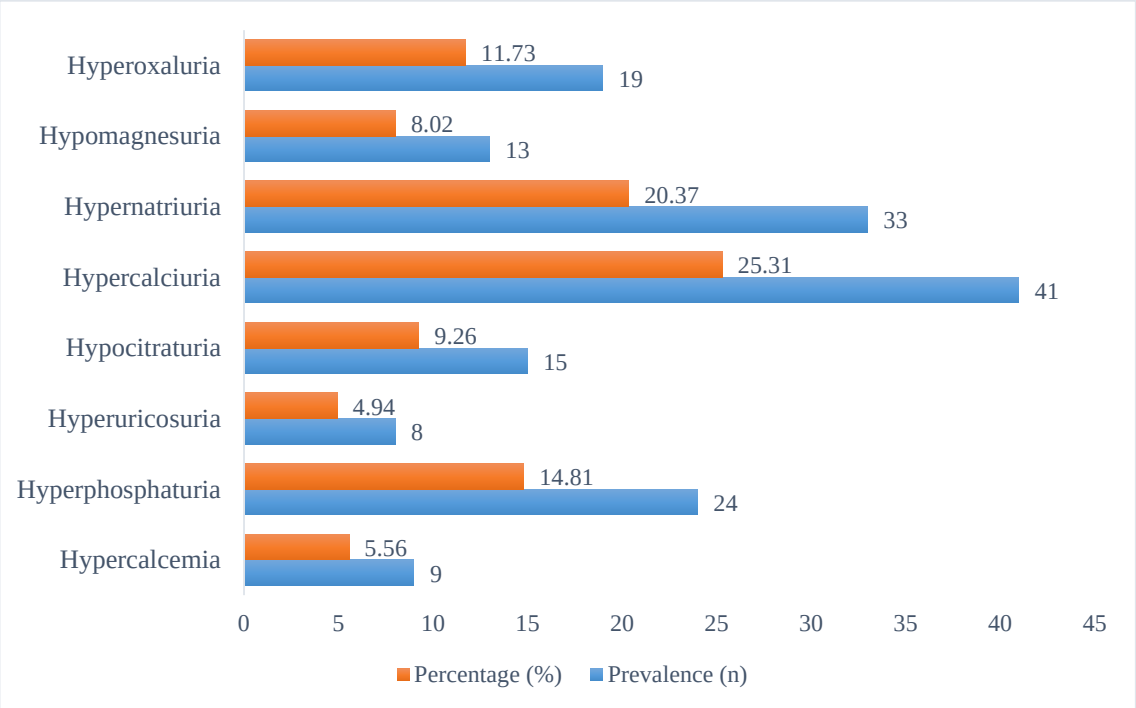

Figure 1: Metabolic Abnormalities: Prevalence and Distribution

The table 3 displays the prevalence of metabolic abnormalities in patients with urinary stones and their association with urinary tract infection (UTI). Hypercalcemia (p = 0.085), hyperphosphaturia (p = 0.422), hyperuricosuria (p = 0.297), and hypocitraturia (p = 0.72) did not show a statistically significant association with UTI. However, hypercalciuria exhibited a significant association (p = 0.001), suggesting a link between elevated urinary calcium levels and UTI. Conversely, hypernatriuria (p = 0.792), hypomagnesuria (p = 0.795), and hyperoxaluria (p = 0.702) did not demonstrate significant associations with UTI in this cohort.

Table:3 Chi-Square Test for Categorical Variables

Variable	**UTI**	**No UTI**	**Total**	**p-value**
Hypercalcemia	5	4	9	0.085
Hyperphosphaturia	11	13	24	0.422
Hyperuricosuria	5	3	8	0.297
Hypocitraturia	7	8	15	0.72
Hypercalciuria	25	16	41	0.001
Hypernatriuria	21	12	33	0.792
Hypomagnesuria	6	7	13	0.795
Hyperoxaluria	9	10	19	0.702

The laboratory test results, obtained from patients with urinary stones and a median age of 45 years, reveal potential metabolic links to both urinary tract infections (UTIs) and stone formation. Urine analysis showed a median pH of 6.5 (slightly acidic), specific gravity of 1.015 (moderately concentrated), elevated creatinine (150 mg/dL) and uric acid (350 mg/dL), and high calcium (250 mg/dL) and oxalate (40 mg/dL) levels—all contributing to stone formation. Serum analysis indicated normal kidney function but slightly elevated uric acid (5.5 mg/dL) and phosphate (3.5 mg/dL), potentially associated with metabolic diseases and UTIs (table 4).

Table 4: Comprehensive Laboratory Test Results Revealing Metabolic Parameters and Urinary Characteristics in Patients with Urinary Stones

Parameter	**Unit**	**Median (IQR)**
Age	years	45 (32-58)
Urine Analysis		
pH	-	6.5 (6.0-7.0)
Specific Gravity	-	1.015 (1.010-1.020)
Creatinine	mg/dL	150 (120-180)
Uric Acid	mg/dL	350 (300-400)
Calcium	mg/dL	250 (220-280)
Phosphate	mg/dL	40 (35-45)
Oxalate	mg/dL	40 (35-45)
Citrate	mg/dL	300 (280-320)
Magnesium	mg/dL	20 (15-25)
Serum Analysis		
Urea	mg/dL	30 (25-35)
Creatinine	mg/dL	1.0 (0.8-1.2)
Uric Acid	mg/dL	5.5 (5.0-6.0)
Phosphate	mg/dL	3.5 (3.0-4.0)
Calcium	mg/dL	9.5 (9.0-10.0)

In our study, the logistic regression analysis reveals compelling associations between urinary tract infection (UTI) and various factors among patients with urinary stones (table 5). UTI exhibits a significant association with an odds ratio (OR) of 2.54 (p = 0.005), highlighting a heightened likelihood of UTI in this population. Notably,hypercalciuria emerges as a major contributor,

showing a substantial association with UTI (OR: 3.87, p = 0.0002). While stone composition, particularly calcium oxalate, demonstrates a suggestive association (OR: 1.89, p = 0.062), gender, age, and hypercalcemia do not exhibit significant associations with UTI.

Table 5: Associations between UTI and Metabolic Diseases, Stone Composition, and Demographics: A Logistic Regression Analysis

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
UTI	2.54	1.32 - 4.89	0.005
Metabolic Disease A (Hypercalcemia)	1.21	0.55 - 2.65	0.623
Metabolic Disease B (Hypercalciuria)	3.87	1.95 - 7.68	0.0002
Stone Type (Calcium Oxalate)	1.89	0.97 - 3.68	0.062
Gender (Male)	0.75	0.42 - 1.35	0.341
Age (45-55 years)	1.46	0.85 - 2.52	0.175

Discussion

This study examined the complex connection between urinary tract infections (UTI) and metabolic disorders in individuals with urinary stones, offering important new information in a field of research that has received little attention. Our study was based on a cohort of 162 patients who were diagnosed with urinary stones at Saidu Group of Teaching Hospital, Swat, Pakistan, between January and December 2022. The demographic profile of our research showed that the gender distribution was balanced (male: 48.14%, female: 51.86%) and that the study group was heterogeneous in terms of age, race, and geography. The fact that 58.64% (n=95) of participants had a history of prior UTIs highlights the therapeutic importance of determining if urinary stones and UTIs coexist in this group of patients.

Participants in our study had a significant prevalence of metabolic illnesses, such as hypercalciuria (n=39; 24.07%) and diabetes mellitus (n=47; 29.01%). These data support the widespread understanding that metabolic diseases have an impact on the development of stones (15, 16). In addition, our study filled a significant vacuum in the literature by providing unique insights into the microbial profiles and patterns of antibiotic resistance linked to UTIs in Pakistani patients with urinary stones (17, 18). Our research offers region-specific insights that account for factors like genetic predisposition and environmental conditions contributing to urinary stone formation in the Pakistani population when compared to existing studies, especially those conducted in diverse geographical contexts.

37.65% (n=61) of the patients in our research study had recurring bladder stones, which is consistent with trends seen in other studies [19,20], highlighting the persistent nature of stone development. Comparably, our study's prevalence rates of renal stones (64.20%, n = 104), ureteric stones (22.84%, n = 37), and the coexistence of renal and ureteric stones (12.96%, n = 21) support patterns documented in earlier research [21], adding to the body of knowledge regarding the distribution and properties of stones. The finding that 59.88% (n=97) of participants reported lumbar pain as a common presenting complaint is consistent with previous research, which highlights the persistent variation in clinical symptoms linked to consequences from urinary stones [22]. Our study revealed different compositions of stones, with the most common component being calcium oxalate (n=133; 82.10%). This is consistent with the body of research [23] that shows calcium oxalate is often present in kidney stones.

A thorough picture of the metabolic landscape in our research population was also provided by the prevalence of metabolic anomalies, such as hypercalcuria (n=41; 25.31%), which our study also showed. Moreover, our results highlight the importance of higher urine calcium levels in UTI incidence by showing a significant correlation (p = 0.001) between UTI and hypercalciuria. This is consistent with the body of research that shows how hypercalciuria increases the risk of UTIs and stones. These results were supported by the logistic regression analysis, which showed a strong

correlation (OR: 3.87, p = 0.0002) between hypercalciuria and UTI. Other metabolic variables, such as calcium oxalate content of stones and hypercalcemia, did not, however, show any discernible correlations with UTI. This implies that while hypercalciuria is a strong indicator of urinary tract infections, the connection with other metabolic variables may be more complex.

Conclusion

In summary, our research provides important new information on a largely unstudied topic by illuminating the complex interplay between urinary tract infections (UTIs) and metabolic disorders in people who have kidney stones. The research population in Pakistan has a broad demographic profile that underscores the urgent health risks associated with metabolic illnesses and urinary tract infections (UTIs), particularly when considering heightened risk factors including genetic predisposition and dietary behaviors. Our results highlight the noteworthy occurrence of metabolic disorders, with Diabetes Mellitus and Hypercalciuria being the most common. Furthermore, the research highlights the connection between increased urine calcium levels and the prevalence of UTIs by demonstrating a strong correlation between UTI and hypercalciuria. Although hypercalciuria was shown to be a significant predictor, the associations with other metabolic variables and the composition of the stone were not as clear.

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