

Frequency of Infected Renal Stones in Patients Presenting to Institute of Kidney Diseases

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ABSTRACT

Background: Infected renal stones are a clinically aggressive subtype of urolithiasis that occurs due to the ability of urease producing bacteria and frequent UTIs. There is little local data available of their prevalence in high-burden areas such as Pakistan, despite being related to rapid stone development, staghorn form, and transition to chronic kidney disease. This study was done to determine the prevalence and clinical presentation of the infected renal stones in patients who presented with renal calculi in one of the tertiary urology centers in Peshawar.

Methods: This was a prospective, single-center, cross-sectional study conducted by the researchers at the Institute of Kidney Diseases in Peshawar, Hayatabad Medical Complex. Non-probability sequential sampling was employed to sample 246 patients who had radiographic appearance of renal calculus during a 6-month time. The age of the patients was 18-75 years. Any kidney stone shortlisted as infected had to come together with indications of some infections within the urinary system and confirmed by a positive urine culture ($\geq 10^5$ CFU/mL) or a stone culture. Using SPSS version 29.0 we were able to analyze structured proforma data which had demographics, clinical, laboratory as well as microbiological information.

Results: Renal stones were infected in 23.6 percent (58/246). The patients were more likely to have infected stones as compared to patients who did not have the conditions (34.0% vs. 50.0% patients with diabetes mellitus, 82.8% vs. 31.4% one infection after the other) and patients seeking medical assistance were more likely to possess a stone (41.4) than those who did not seek medical assistance (34.0). Proteus species was the most predominant uropathogen at 67.2 followed by Escherichia coli with 39.7. Infected stones had a strong correlation with larger average stone size (24.8 $\pm$ 10.4mm vs 16.7 $\pm$ 8.1mm, $p < 0.001$), higher staghorn morphology frequencies (48.3 $\pm$ 6.9 $\pm$ 0.001), increased serum creatinine, increased surgical intervention, and the prolonged hospital stay ($p = 0.05$).

Conclusion: Infected kidney stones can be considered responsible of approximately 25% of patients with nephrolithiasis in our case. These stones are linked to the female population, Frequent UTIs, diabetes, etc. more severe illnesses. To decrease morbidity, it is necessary to screen stone patients with infections on regular basis especially in the high-risk population, culture-based therapy, and timely surgical debridement. Bigger multicentric studies are required in order to inform preventive initiatives in Pakistan in region-specific contexts.

Keywords: Infected renal stones, struvite calculi, urinary tract infection, staghorn calculi, urolithiasis, Pakistan

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1. INTRODUCTION

Renal calculi (also known as kidney stones) is one of the common health conditions that occurs in approximately 10-15 percent of the global population at some point in life [1]. They take place when minerals available in the urinary system get supersaturated and crystallize to form solid concretions [2]. Whereas most of the kidney stones consist of calcium oxalate or calcium phosphate, there is a group that is termed as infected renal stones. Such stones are identified by struvite which is magnesium ammonium phosphate [3]. This sub group is found more in cases of recurrent UTIs.

Uncharacteristic urease-performing microbes such as Klebsiella, Pseudomonas and Proteus normally lead to the formation of infected kidney stones in lime-acquiring urine. The metabolism of urea into carbon dioxide and ammonia by these bacteria increases the urine pH and favours the growth of crystals [4]. Infected stones can occupy the renal pelvis and the calyces and usually develop rapidly creating staghorn calculi. The infection that comes with such stones is normally chronic or recurrent. The fact that they lead to renal parenchymal damage, chronic pyelonephritis and finally end-stage renal disease (ESRD) when neglected is quite interesting [5].

Infectious kidney stones is a significant dilemma that makes management of the patient a major challenge. Symptoms

include fever, chills, lethargy and the appearance of blood in urine among other common cold like symptoms. People with compromised immune systems, including the very elderly, have higher chances of urosepsis, which is a potentially fatal disease [6]. These may require surgery, e.g. percutaneous nephrolithotomy (PCNL), extracorporeal shock wave lithotripsy (ESWL), or, in the most severe cases, nephrectomy, to eliminate the stones since bacteria penetrate the biofilm and the stone matrix thereby rendering elimination of these stones hard with even the most potent antibiotics [7].

Due to the variations in geography, nutrition, heredity, and socioeconomic status, there is a significant difference in the occurrence of infected renal stones among groups [8].

The developing countries such as Pakistan, which happens to be in the global stone belt, have higher risks of developing untreated or poorly treated UTIs, delayed diagnosis, limited access to health care, poor sanitation and just poor health in general [9]. Even though the prevalence of struvite stones among the causes of urolithiasis can be that low (515 percent worldwide), recent epidemiological studies indicate that such stones are far more frequent in those localities where UTIs are widespread [10]. Regional studies in South Asia among urolithiasis patients have reported up to 18% strontium [urolithiasis] stone rates stratified on the basis of struvite-infected stone [11].

Based on the clinical significance of infected renal stones in patients with nephrolithiasis in Pakistan, there is a lack of extensive local data estimating the incidence of the condition. The research gap is the absence of investigation regarding infection-specific factors available, as majority of research is conducted on general stone illness or UTI-stone relationships [12]. Dedicated frequency estimates should exist in tertiary urology practice, but a single interesting cross-sectional study in Peshawar has discovered renal stone disease among patients with known UTI in 19.56 percent, which may suggest a correlation. Such informational deficit makes it more difficult to establish region-specific screening programs, effective infection control strategies and region-specific treatment recommendations.

2. METHODS

This prospective single-center cross-sectional study was conducted in the Urology Department of the Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar, Pakistan. The Institute is a tertiary-care referral center that manages patients with urolithiasis from across Khyber Pakhtunkhwa province and the surrounding regions.

Ethical approval was obtained from the Institutional Review Board and Ethical Committee of Hayatabad Medical Complex (Ref. No. 597/Chairman/R&E/Committee/IKD) and the College of Physicians and Surgeons Pakistan (Ref. No. CPSP/REU/URO-2025-021-10173). The study was carried out from October 4, 2025, to April 3, 2026.

Sample size was calculated using the World Health Organization sample size calculator. A total of 246 participants were required based on a 95% confidence interval, a 5% margin of error, and an anticipated prevalence of 19.56% for infected renal stones according to previously published regional data [12].

A non-probability consecutive sampling technique was used. Written informed consent was obtained from all patients who fulfilled the inclusion criteria. Inclusion criteria were:

- (1) willingness and ability to participate in the study and provide written informed consent,
- (2) age between 18 and 75 years, and (3) patients of either gender.

The renal calculus radiological evidence may be confirmed through ultrasonography, plain X-ray KUB, or non-contrast CT scan over the kidneys, ureters, and bladder. Patients with inadequate clinical or laboratory data, diagnosed with known malignancy, immunocompromised (e.g. HIV/AIDS patients or patients who received organ transplants and are taking immunosuppressive medication), or isolated non-renal urolithiasis (e.g. bladder stones or ureteral stones alone) were excluded. In order for a kidney stone to be considered infected, it must be present with fever, dysuria, or flank pain, as well as be proven to have at least 10^5 colony-forming units per millilitre of uropathogen in a urine culture or to have bacterial growth within the stone matrix on microbiological analysis of stone fragments. Urinary tract infection diagnosis was considered to occur when the uropathogen concentration of a clean-catch urine sample taken in the midstream was at least 10^5 CFU/mL and at least one of the symptoms had occurred including dysuria, urgency, frequency, or fever. A structured case report form was distributed to each participant who signed his/her written informed consent either in English or Urdu, according to the case. The form requested such information as age, gender, residence, occupation, and level of education, and the information regarding the nature of clinical manifestation such as flank pain, fever, dysuria, hematuria, nausea, vomiting, chills, or rigors. It was also enquiring the duration of the symptoms, whether the participant had kidney stones history, recurrent UTI, or comorbidity, such as diabetes mellitus. The normal laboratory work included a complete blood count, serum creatinine, urinalysis to examine pyuria, hematuria, and urine PH. Under aseptic conditions, a mid-stream urine sample was collected and tested in culture and sensitivity. Microbiological culture and sensitivity of the stone pieces were done to determine the presence of any internal bacterial colonization in patients undergoing surgical procedures like percutaneous nephrolithotomy, open nephrolithotomy, or any other surgery. The imaging findings were also documented and included imaging modality, stone size (in millimeters), site, and staghorn vs non-staghorn morph type. A positive urine culture among symptomatic patients or positive culture of the stone confirmed the diagnosis of an infected renal stone provided the patient met the operational criteria. All our data was entered using IBM SPSS Statistics for Windows, version 29.0. Percentages and frequencies were employed to display the categorical variables such as gender, infection status, uropathogens found, and stone type in addition to co-morbidities. The models used median and interquartile range or mean plus or minus standard deviation, such as age, stone size, symptom duration, and laboratory values, as they are continuous variables affected by the distribution of the data. By dividing the overall number of patients with renal calculi by the

frequency of infected renal stones, the main outcome was determined. The subgroup analysis conducted was based on the variables age, gender, urban/rural status, history of diabetes, and recurrent UTI. The p-value below 0.05 was checked as significant in case of testing associations with the Fisher-exact test or chi-square test according to the kind of test. The written informed consent was provided by all the participants prior to the start of the research, and the study was conducted according to all the provisions of the Declaration of Helsinki. Patients were given the freedom to withdraw their participation at any point without affecting their normal clinical care and the research was researched by the Institutional Review Board of Hayatabad Medical Complex prior to the research. The data was securely saved after being anonymized.

3. RESULTS

The number of people included in the frames of investigation was 246 individuals experiencing radiographic evidence of renal calculi. With 158 men (64.2%) and 88 females (35.8%), the average age of the participants was 37.4 ± 13.8 years. Most of the patients were residing in the rural areas ($n = 162$, 65.9%). A relatively low percentage of patients had the history of diabetes mellitus ($n = 68$, 27.6%), and slightly less percentage had recurrent urological tract infections ($n = 112$, 45.5%).

Table 1. Demographic and clinical characteristics of patients with renal calculi according to infection status (n = 246)

Variable	Total (n=246)	Infected (n=58)	Non-infected (n=188)	p- value
Age (mean $\pm$ SD, years)	37.4 ± 13.8	39.2 ± 14.1	36.8 ± 13.6	0.21
Male, n (%)	158 (64.2)	29 (50.0)	129 (68.6)	0.01
Female, n (%)	88 (35.8)	29 (50.0)	59 (31.4)	0.01
Rural residence, n (%)	162 (65.9)	41 (70.7)	121 (64.4)	0.38
History of recurrent UTI, n (%)	112 (45.5)	48 (82.8)	64 (34.0)	<0.001
Diabetes mellitus, n (%)	68 (27.6)	24 (41.4)	44 (23.4)	0.008
Previous kidney stones, n (%)	79 (32.1)	19 (32.8)	60 (31.9)	0.90

There were 58 out of 246 cases of infected renal stones, or 23.6% of the total. The patients who were found to have diabetes mellitus, had recurrent UTIs or were females were at a significantly increased risk of infected stones.

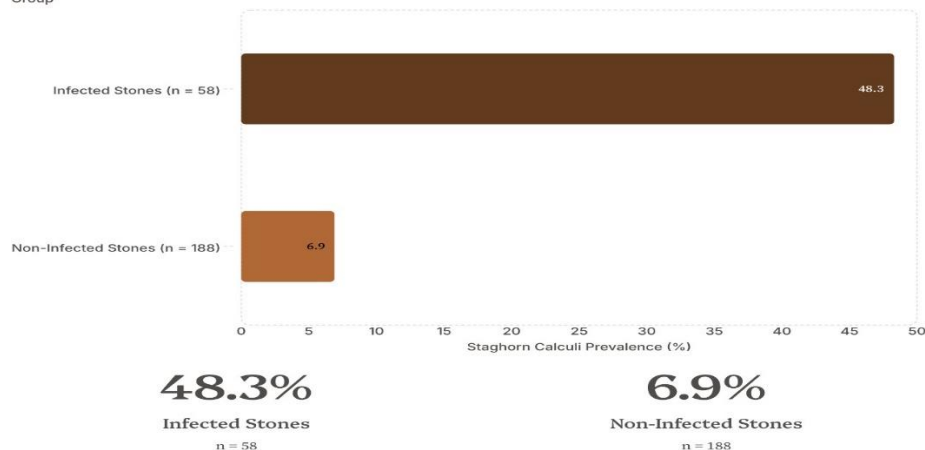
Table 2. Clinical presentation, laboratory findings, and imaging characteristics according to infection status

Variable	Total (n=246)	Infected (n=58)	Non-infected (n=188)	p-value
Flank pain, n (%)	214 (87.0)	52 (89.7)	162 (86.2)	0.49
Fever, n (%)	89 (36.2)	47 (81.0)	42 (22.3)	<0.001
Dysuria, n (%)	76 (30.9)	39 (67.2)	37 (19.7)	<0.001
Pyuria on urinalysis, n (%)	131 (53.3)	55 (94.8)	76 (40.4)	<0.001
Urine pH >7.0, n (%)	67 (27.2)	41 (70.7)	26 (13.8)	<0.001
Staghorn calculi on imaging, n (%)	41 (16.7)	28 (48.3)	13 (6.9)	<0.001
Mean stone size (mm)	18.6 ± 9.2	24.8 ± 10.4	16.7 ± 8.1	<0.001

Figure 1. Prevalence of Staghorn Calculi in Infected vs. Non-Infected Renal Stones

Bar chart comparing staghorn calculi prevalence between culture-positive (infected) and culture-negative (non-infected) renal stone groups.

Group



Absolute difference: **41.4 percentage points**. Infected stones were **7× more likely** to present as staghorn calculi compared to non-infected stones ($p < 0.001$). Culture positivity defined by intraoperative stone culture.

Figure 1. Distribution of stone morphology (staghorn versus non-staghorn) in infected and

non-infected renal stone groups.

A total of 58 infected patients resulted in a positive urine culture, 55 (or 94.8) of the infected patients who were operated on received a positive culture of the stones which further confirmed internal colonisation. Table 3 below lists the microbiological profile of identified uropathogens.

Table 3. Microbiological profile of uropathogens isolated from urine and stone cultures in infected renal stone cases (n = 58)

Organism isolated	Urine culture positive (n=55)	Stone culture positive (n=36)	Overall frequency (%)
Proteus species	21 (38.2)	18 (50.0)	39 (67.2)
Escherichia coli	14 (25.5)	9 (25.0)	23 (39.7)
Klebsiella pneumonia	9 (16.4)	5 (13.9)	14 (24.1)
Pseudomonas aeruginosa	6 (10.9)	3 (8.3)	9 (15.5)
Mixed growth	5 (9.1)	1 (2.8)	6 (10.3)

Compared to the non-infected cases, abnormalities in patients with infectious renal stones were more prevalent, namely staghorn morphology, larger stones, elevated blood creatinine levels, bilateral stones, and an increased hospital stay. Each patient was provided with the traditional clinical care according to the institutional rules, and no acute issues were observed in the process of data gathering. The results at hand highlight the importance of early intervention and targeted screening among high-risk groups and the superficial occurrence of infected renal stones in the sample.

4. DISCUSSION

In this study, infectious renal stones were observed in 23.6 percent of renal calculus-reporting patients. According to the prior local study conducted in Pakistan, it was found that 19.56% is prevalent in the area [13], thus it is in the top category of the presence of infection-related stones in the South Asians residents [14,15]. The issue of infected urolithiasis has been higher in developing countries where UTIs continue to be under-addressed, as the prevalence rates are much higher than the 5-15% global average prevalence of struvite stones reported in the western literature [16,17]. It was startling to learn that the percentage of infected stones among female patients (50.0% versus 31.4% in the non-infected study population) is staggering. This gendered inclination to infection stones has been reported by many studies that have indicated that women are at a higher risk of infection stone due to lifetime prevalence of urinary tract infections [18,19]. The two causes might be different in our community like an anatomical difference of shorter urethra and hormone influence [20]. The strongly observed two-way interaction between urolithiasis and urethritis is verified by the high interrelation among infected renal stones and infection in the history of recurrent urinary tract infections (82.8-34.0, $p < 0.001$) [21,22]. There was also much more prevalence of diabetes mellitus in the infected group (41.4 vs. 23.4, $p = 0.008$). There is a high likelihood that poor glucose regulation and low immune response among diabetes patients facilitates bacterial colonization and subsequent formation of stones [23,24]. Proteus species was the dominant uropathogen (67.2% of the cases) followed by Escherichia coli and Klebsiella pneumoniae. This microbiological distribution is in line with past studies that show that urease-producing organisms are present in infection-related stones located throughout the world [25,26]. Due to its high urease activity and rapid alkalization of urine and promoting the rapid development of staghorn calculi [27,28], the high rate of Proteus isolation is particularly concerning. The indicators of renal functions were worse, larger the size of stones; higher the frequency of staghorn shape in infected stones (48.3 vs 6.9). These findings support previous arguments that infectious stones, bear a more aggressive clinical course, which is more likely to lead to a renal parenchymal injury and requires surgery more frequently [29,30]. Due to the morbidity and healthcare burden, the duration of hospitalization and rate of surgery were also longer in the patients with contaminated stones. The study was also a prospective design, the urine and stone cultures were used to diagnose, and the enrollment was through a high-volume tertiary center providing the research with a vast population to cover which are the strengths of the research. The findings are not generalizable to other regions of Pakistan since the research was conducted in only one area. Besides, due to the scarcity of resources, we omitted stone composition analysis. Lastly, infected renal stones are associated with female gender, frequent UTIs, diabetes, and an even more important proportion of urolithiasis patients within our surrounding. These results emphasize the urgency of more effective UTI prevention initiatives, early infection screening in patients with stones, and early surgical intervention in the setting with limited resources.

5. CONCLUSION

In this cross-sectional study involving a single-center study, 23.6 percent of subjects with renal calculi had an infected renal stone. UTIs that recurred and diabetes mellitus were also useful predictors of these stones and they were comparatively more common in females. Larger stones, staghorn-shaped stones, compromised renal function, more surgical intervention, extended hospital stay, and Proteus species were correlated with infectious stones and considered most frequent in the pathogenesis of the urethra. This study highlights that in our community, infected kidney stones represent a high and

clinically aggressive subset of urolithiasis, which imposes an undue number of morbidities into a setting where financial resources are limited. In light of the research, patients who present with kidney stones ought to be periodically screened regarding urinary tract infections (UTIs). This is more so in the high-risk population such as women, diabetics, and people with frequent UTIs. Early diagnosis, prompt antibiotic therapy based on culture sensitivity, and prompt surgical removal of affected calculi are the keys to preventing chronic kidney disease and reducing healthcare expenses. Larger multicenter studies which examine the compositions of stones may further validate these findings and directive in creating region-specific preventive and care procedures in Pakistan and other areas, which are high-prevalence sites. The number and outcomes of infected kidney stones may be reduced significantly in similar situations in case the policy of public health were focused on the prevention of UTIs, enhanced cleanliness and diabetes management

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