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Community-Acquired Infection among the Hospitalized Renal Stone Patients

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Abstract

Background One of the most prevalent long-term kidney disorders in high-blood-pressure patients is nephrolithiasis. This study involves collecting urine and renal stones from patients with urinary tract infection (UTI) to analyze how hospitalized patients with UTI contract community infections. The samples were collected at the Sulaimaniyah Surgical Teaching Hospital urology and extracorporeal shock wave lithotripsy (ESWL) staff. It is understood that UTIs contribute to the formation of kidney stones.

Methods Screened and cultured urine requires careful collection, transport, and interpretation. Urine samples were collected from the patients with UTI at the Sulaimaniyah teaching hospital for culturing. Urine cultures containing pyuria and bacteria indicate UTIs. Microorganisms were studied, inoculated on blood, MacConkey, and mannitol salt agar, and biochemically identified. A bacterial and microbiological examination of kidney stones was conducted at the Sulaymaniyah Surgical Teaching Hospital's ESWL and urology departments. Clean renal stone samples with ethanol for 1 minute, crush using sterile tongs, then culture in 37°C thioglycolate broth for 48 hours. Specimens inoculated on blood, MacConkey, and mannitol salt agars resulted in isolation of staphylococci, streptococci, and *Staphylococcus* spp.

Results In this study, 17 of 48 samples showed microbial growth. Each of *Enterococcus* and *Micrococcus* spp. comprised 12.5% of eight renal intact stone samples. Three of 14 renal intact stone samples showed microbial growth with 7 and 14% for *Enterococcus* and *Escherichia coli*, respectively. From eight urine samples before and after ESWL procedure, *E. coli* isolation incidents doubled from 12.5 to 25%, while *Staphylococcus* spp. remained the same at 12.5%. Out of 10 UTI urine samples, 20% *Staphylococcus* spp., *E. coli*, and 10% *Pseudomonas* spp. were isolated.

Keywords
- renal stone disease
- urinary tract infection
- bacteria
- struvite
- extracorporeal shock wave lithotripsy
- urine culture

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Conclusion This study related renal stones to *E. coli*, enterococci, *Micrococcus luteus*, and staphylococci. After ESWL, the urine samples revealed *E. coli* growth, whereas comparable urine samples before ESWL did not. Thus, urinary infections can cause kidney stones. Eighteen of 48 kidney stone samples tested positive for *E. coli*, 22 for staphylococci, 11 for enterococci, 5 for *Pseudomonas*, 5 for *Proteus*, and 5 for micrococci.

Introduction

The second most common chronic kidney condition is nephrolithiasis. Urinary stone disease is rising in all age groups and genders; about 10% of the population get kidney stones.[1] Urolithiasis, ureterolithiasis, and cystolithiasis are nephrolithiasis symptoms.[2] Genetic and environmental factors increase kidney stone risk. Monogenetic defects cause cystinuria, Dent's disease, and primary hyperoxaluria,[3] and environmental variables like food contribute to stone formation.[4]

Kidney stones result from urinary tract infections (UTIs), cystinuria, poor urine volume, stasis, systemic acidosis, oxalate, and salt.[5] Stone component crystal nucleation, aggregation, or development to a size that may interact with intrarenal structure, and renal system retention and maintenance induce secondary nucleation and clinical stone formation.[4,6] Western diets, mental stress, obesity, and inactivity increase kidney stone risk; a healthy diet lowers it.[7]

Many gram-positive and gram-negative bacteria, fungi, and viruses cause UTIs.[7] *Escherichia coli*, *Enterococcus*, and other natural flora bacteria cause most UTIs.[8] Most UTIs are bacterial.[9] Struvite kidney stones are bacterial.[10] Calcium oxalate generates 70 to 75% renal stones.[11] Renal stones can cause hematuria and gastrointestinal (GI) discomfort. Renal calculi increase oxalate, uric acid, phosphate, calcium, cysteine, and xanthine, and decrease urine volume.[12] Renal calculi also includes specific symptoms such as stomach discomfort and hematuria.[13]

Renal stones crystallize differently. Below 5.5 pH, uric acid kidney stones form. Formation of stones is more common among men. Gout and chemotherapy patients may be at higher risk of having kidney stones. Uric acid kidney stones account for 10% of all kidney stones, second to calcium oxalate kidney stones.[14] Calcium kidney stones in men are oxalate or phosphate. Most renal calcium stones are 70 to 75% oxalate.[15] Renal stones can result from high calcium, hypocitrate, and poor urine volume.[16] Vitamin C may increase oxalate.[17] UTIs in women often contribute to struvite or triple phosphate kidney stones. Rocks limit urethras, which results in renal infection. Struvite stones form when *Proteus*, *Providencia*, *Klebsiella*, *Pseudomonas*, and enterococci decompose urea.[18] Because cysteine is poorly soluble, inherited kidney stone disorders are infrequent in men and women. Urine cysteine solubility rises with increase in urine pH level.[19]

We use the term "UTI" to describe any bacterial infection of the kidneys, ureters, bladder, or urethra. Bladder and urethra are in the lower urinary tract. Kidney and ureters are in the upper oral tract. That part of your body will hurt, be red, and swell up. Most of the bacteria that cause UTIs get into the urethra and kidneys through the bladder. Urine stays in the bladder until it leaves the body, which leads to pyelonephritis. The kidney infection pyelonephritis makes your back hurt, your urine changes color and smell, and it hurts to urinate. Pathogenic bacteria can sometimes make the urine red.[20] Bacteria, fungi, and viruses cause UTIs. Usually, bladder and urethra bacteria cause UTIs. Gram-positive *Enterococcus* species dominate gut flora and cause nosocomial infections.[21] *E. coli* gram-negative gut bacteria cause UTIs. *E. coli* causes UTI in adults and food poisoning in kids.[7,22] Common kidney stone cultures contain *E. coli* and *Pseudomonas*,[23] which are disease-causing gram-negative bacteria. The urinary system hosts *Proteus mirabilis*, especially in catheterized patients.[24]

Culture kidney stones for urine infection germs to prove the link. Struvite-forming urease-splitting bacteria follow *E. coli* and *Pseudomonas* spp. in stone cultures.[25,26] This study uses cultural, morphological, and biochemical methods to isolate and identify urine isolates from patients with renal stones to determine if bacterial infection causes renal stone disease.

Materials and Methods

Participants

Thirty-two patients from extracorporeal shock wave lithotripsy (ESWL) and urology operation departments of the Sulaimaniyah Surgical Teaching Hospital were considered in the current investigation. Ten patients with UTI who were receiving treatment at the Sulaimaniyah Surgical Teaching Hospital's urology department were also included in the current study to look at the relationship between UTI and kidney stone formation.

Specimens for the Investigation

Urine Sample

Urine is the specimen fluid that is most frequently submitted for screening and culture. Sample collection, transport, culture techniques, and result interpretation should be done with utmost care. The night before the culture of urine, the patient should be advised to refrain from urinating until the specimen is collected the next morning. Three types of urine samples comprising 8 urine samples before the breakdown of renal stones by ESWL instrument, 8 urine samples

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Table 1 Results of culture samples

Culture	No. of samples	Growth positive	Growth negative
Broken stone after ESWL	8	2	6
Intact stone from operation	14	3	11
Urine before ESWL	8	2	6
Urine after ESWL	8	3	5
Urine from patients with UTI	10	7	3

Abbreviations: ESWL, extracorporeal shock wave lithotripsy; UTI, urinary tract infection.
Note: Total number of culture samples = 48.
Growth positive result = 17 (~35.41%).
Growth negative result = 31 (~64.58%).

after the breakdown of renal stones breaking by ESWL instrument, and 10 urine samples from patients with UTI in the urology department of the Sulaimaniyah Surgical Teaching Hospital were collected.

Renal Stone Sample

Renal stones from two diverse sources were considered for the present investigation. About eight broken renal stones were collected from the ESWL department and sent to the medical laboratory for bacterial analysis. Fourteen intact renal stone samples were collected from the urology operation department of the hospital and sent to the medical laboratory for microbial analysis.

Culturing of the Specimens Collected

Urine Culture

Urine cultures are mostly used to diagnose bacterial UTI (kidneys, ureter, bladder, and urethra). Urine is an excellent culture and growth medium for most of the organisms that affect the urinary tract. Pyuria (pus in the urine) and presence of significant bacteria strongly suggest the possibility of a UTI. The collected urine specimens were cultured on three different culture media, which included blood agar plate, MacConkey agar and mannitol salt agar, and were screened for significant bacteria. The screening resulted in isolation of staphylococci and streptococci and gram-negative bacteria.

Stone Culture

The collected renal stone samples from the departments of urinary ESWL and urinary operation in the Sulaimaniyah Surgical Teaching Hospital were sent to the bacteriological laboratory department. The renal stone samples were sterilized for 1 minute by adding ethanol and then crushed into pieces by sterile tongs, then placed in the enriched media (thioglycolate broth) and incubated for 48 hours at 37°C. After incubation, the specimens are inoculated and cultured on three different media, which included blood agar plate, MacConkey agar, and mannitol salt agar, to isolate staphylococci and streptococci, and gram-negative bacteria.

Results and Discussion

In the present investigation, a total of 48 samples of broken renal stones from ESWL, intact renal stones from operation, urine samples before ESWL, and urine sample after ESWL from patients with UTI were collected. Seventeen samples showed positive results and others showed no microbial growth. The results are given in ►**Table 1**.

Broken Stone Sample from ESWL-Culture Studies

Eight samples of renal intact stone were cultured in the bacteriological laboratory department of the Sulaymaniyah Surgical Teaching Hospital, and we found the following: *Enterococcus* (12.5%), *Micrococcus* spp. (12.5%), and no growth (75%).

Intact Renal Stone Sample from Operation-Culture Studies

Fourteen samples of renal intact stones were cultured in the bacteriological laboratory department of the Sulaymaniyah Surgical Teaching Hospital, and the investigation found that only three samples were positive for microbial growth. The results were the following: *Enterococcus* (7%), *E. coli* (14%), and no growth (79%).

Urine Sample before ESWL-Culture Studies

Eight urine samples were collected from the patients before the ESWL procedure and the samples were cultured in the bacteriological lab with the following results: *Staphylococcus* spp. (12.5%), *E. coli* (12.5%), and no growth (75%).

Urine Sample after the ESWL Procedure

Eight urine samples from different patients were collected after the ESWL procedure (renal stones are broken down during the ESWL procedure). The urine samples were cultured in the bacteriological lab and we found the following results: *E. coli* (25%), *Staphylococcus* spp. (12.5%), and no growth (62.5%).

Urine Sample from Patients with UTI-Culture Studies

Ten urine samples were collected from different patients with UTI and cultured for microbial growth. We found the following results: *Staphylococcus* spp. (20%), *E. coli* (40%), *Pseudomonas* (10%), and no growth (30%).

Conclusion

According to the findings of the current study, several pathogenic bacteria and renal stone diseases are clinically

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related when urine and stone culture assays for some patients of renal stone are positive. Crystal clumping increased in the presence of bacteria due to the selective aggregation of certain stone types seen in individuals with renal stone disease. Some bacteria caused reduced amounts of urine citrate and increased calcium oxalate deposits. In addition, kidney stones made of ammonium urate, which are more frequently combined with struvite stones, are mostly caused by an infection with urea-splitting microorganisms like certain bacteria. *Proteus*, *Klebsiella*, *Pseudomonas*, *Providencia*, *Serratia*, and *Staphylococci* are a some of the bacteria that are classified as urease-producing bacterial strains. A model organism for a UTI is *P. mirabilis*. These various bacteria produce crystalline biofilms on inserted urinary catheters, causing polymicrobial infection and infection stones in the urinary system.

Recommendations

The outcomes of this investigation suggest the need for further investigation into the highlighted research question. Given that the study is not free of limitations, we recommend targeting larger populations along with a feasible plan to avoid administration of antibiotic to patients prior to sample collection. It is worth mentioning that utilizing advanced technologies for bacterial identification (starting from ViteK 2 Compact) will increase the efficiency of the work as it significantly saves time and labor-intensive protocols and procedures. Molecular studies on the isolated bacteria can help in forecasting possible genetic variation after comparing new mutant strains with wild types. We also recommend transitioning from qualitative to quantitative studies in the field of study as the size of the research team grows. The focus should be on raising awareness among as many relevant disciplines as possible to implement the potential treatment methods and prophylactic measures.

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Conflict of Interest
None declared.

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