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**Original research article**

# Bacteriological profile of nephrolithiasis: A tertiary care centre experience

**[1]Dr. Satish Rao BS, [2]Dr. Saritha Satish Rao**

[1]Professor, Department of Surgery, Chandramma Dayananda Sagar Institute of Medical Education and Research, Dayananda Sagar University, Karnataka, India

[2]Associate professor, Department of Microbiology, Sri Siddhartha Institute of Medical Sciences and Research Centre, Sri Siddhartha Academy of Higher Education, Karnataka, India

**Corresponding Author:**Dr. Saritha Satish Rao

**Abstract**

**Background:** Renal stone disease is a common medical issue in many regions, leading to significant morbidity and loss of man hours. The disease predominantly affects the economically active population, thus having a socio economic impact. Unlike in the West, where detailed demographic data is available, India lacks comprehensive records on this condition. The prevailing theory is that kidney stones often serve as repositories for bacteria. The question which arises is whether bacterial infection is a precursor to or a result of stone formation. Multiple factors contributing to stone formation have been noted by various researchers. The healthcare burden in the United States alone includes over 185,000 hospital admissions and expenditures surpassing $2 billion annually. Supersaturation of calcium and oxalate in urine, exceeding their solubility limits, have been identified as a primary factor. This study evaluates the bacteriological profile of cultures derived from renal stones and their antibiotic sensitivities to better understand the microbial involvement in stone pathogenesis.

**Methods:** This is a prospective, observational study aimed at analyzing the culture and sensitivity patterns of renal stones obtained from patients undergoing percutaneous and ureteroscopic stone extraction over a period of 18 months.

**Results:** Out of 120 patients studied, 34 patients (28.3%) were culture positive. Of there, coagulase negative staphylococcus isolates noted in 9 patients (26.5%), *E. coli* was the next most common isolate seen in 8 patients (23.5%). Pseudomonas was noted in 6 patients (17.6%), other organisms in 5 patients (14.7%). Acinetobacter was isolated in 1 patient. Analysis of antibiotic susceptibility showed most of these sensitive to varying degrees to aminoglycosides and ciprofloxacin.

**Conclusion:** In conclusion, culture and sensitivity testing of renal stones is a valuable tool in the management of nephrolithiasis, particularly in patients with recurrent or complicated infections. By identifying the bacterial organisms within the stones and determining their antibiotic susceptibility, clinicians can provide targeted treatment, improve patient outcomes, and reduce the risk of recurrenc.

**Keywords:** Culture, sensitivity, renal stone

## Introduction

Renal stone disease, or nephrolithiasis, is a common urological disorder affecting millions of individuals worldwide. The formation of kidney stones can lead to significant discomfort, recurrent infections, and serious complications if not treated appropriately. Although the prevalence varies geographically, it is widely acknowledged that environmental, dietary, and genetic factors contribute to stone formation [1, 2]. In the Indian subcontinent, kidney stones are particularly prevalent due to factors such as hot climate, dietary habits, and inadequate hydration practices, which increase the risk of stone formation [3-6].

One of the key challenges in managing renal stones is understanding their composition and the underlying causes of their formation. Bacterial infections have long been associated with renal stones, with some stones acting as a "tombstone" for bacteria [7-9]. The critical question remains whether bacterial infections precede stone formation or are a consequence of the presence of stones [10]. This has led the focus on culture and sensitivity of these stones, particularly to identify the associated bacterial flora and their antibiotic resistance profiles.

In clinical practice, it is essential to not only treat the symptoms of nephrolithiasis but also to address any underlying infections that may contribute to its recurrence. Culture and sensitivity studies of renal stones obtained during procedures such as Percutaneous Nephrolithotomy (PCNL), ureteroscopic fragmentation etc. can provide valuable insights into the organisms involved and their antibiotic susceptibility [11, 12]. This is particularly important in this era where antibiotic resistance is becoming an global issue, making the effective treatment of infections associated with renal stones more challenging [13-15].

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This study aims to investigate the culture and sensitivity patterns of renal stones in patients undergoing percutaneous and ureteroscopic lithotomy procedures, providing a clearer understanding of the role of bacteria in stone formation and the most effective antimicrobial therapies to manage such infections. Through this study, we seek to improve the management and prevention of renal stone-related infections, reducing the recurrence rate, which in turn will result in better patient outcomes.

**Materials and Methods**

**Study Design:** This is a prospective, observational study aimed at analyzing the culture and sensitivity patterns of renal stones obtained from patients undergoing percutaneous / ureteroscopic stone extraction. The study was conducted over a period of 18 months at the Department of Surgery/urology in collaboration with the Department of Microbiology, at a tertiary care hospital in Bangalore.

**Study Population:** The study population included all patients diagnosed with renal stones who were scheduled for surgery during the study period. A total of 120patients were recruited based on the inclusion and exclusion criteria.

**Inclusion Criteria**

- Patients clinically and radiologically diagnosed with renal stones.
- Patients undergoing Percutaneous /endoscopic procedure for stone removal.
- Patients who provided informed consent for participation in the study.

**Exclusion Criteria**

- Patients with pre-operative urine cultures showing significant bacterial growth.
- Patients undergoing staged procedures.
- Patients with a history of antibiotic therapy within the last 2 weeks.
- Patients with serum creatinine levels exceeding 2.0 mg/dL.

**Procedure**

After obtaining informed consent, detailed patient histories were recorded, including demographic data, clinical presentation, and relevant medical history. Pre-operative urine cultures were performed for all patients as part of routine evaluation. Only those with sterile urine or insignificant bacterial growth were included in the study.

Renal stones were carefully retrieved in a sterile manner in operation theatre and sent to laboratory for culture and sensitivity analysis. Sterile conditions were ensured during the stone extraction process to avoid contamination. The stone fragments were first homogenized, and cultures were performed using standard microbiological techniques.

**Microbiological Analysis**

- **Culture:** The stone fragments were cultured on appropriate media, including blood agar and MacConkey agar, to identify any bacterial growth. The cultures were incubated at 37 °C for 48 hours.
- **Sensitivity Testing:** Antibiotic sensitivity testing was performed using the Kirby-Bauer disk diffusion method. A panel of antibiotics commonly used in treating urinary tract infections was tested, including but not limited to amikacin, gentamicin, ciprofloxacin, piperacillin-tazobactam, meropenem, and vancomycin.

**Data Collection:** The type of bacterial organisms identified from the stone cultures, as well as their antibiotic sensitivity profiles were recorded. Data on patients' demographics, stone characteristics (size, number, location), and any post-operative complications were also documented.

**Ethical Considerations:** The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrolment. Confidentiality of patient data was maintained throughout the study.

**Statistical Analysis:** Data was entered into a Microsoft Excel spreadsheet and analyzed using SPSS VERSION 28.

**Results**

Out of 120 patients studied, 34 patients (28.3%) were culture positive (Table 1). Of there, coagulase negative staphylococcus isolates noted in 9 patients (26.5%), *E. coli* was the next most common isolate seen in 8 patients (23.5%). Pseudomonas was noted in 6 patients (17.6%), other organisms in 5 patients(14.7%). Acinetobacter was isolated in 1 patient (Graph 2). Analysis of antibiotic susceptibility showed most of these sensitive to varying degrees to aminoglycosides and ciprofloxacin. What was

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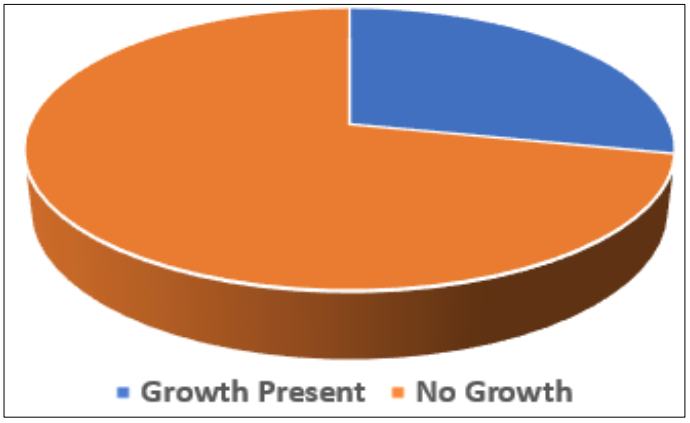
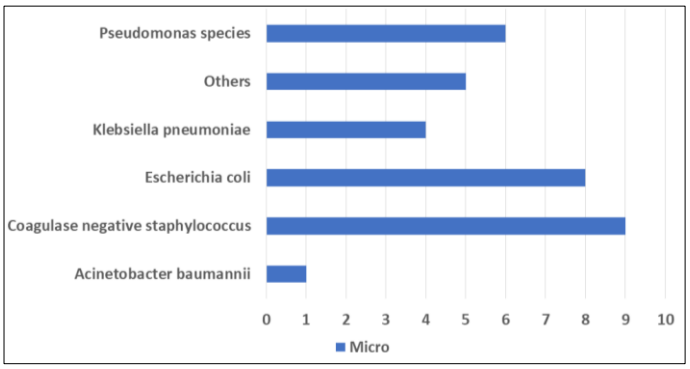
encouraging was most of the culture isolates from renal stones werte susceptible to commonly used antibiotics although Coagulase negative staphylococcus did show significant sensitivity to Teicoplanin and Linezolid and Pseudomonas to carbapenems (Table 2).

**Table 1:** Culture findings

| Growth Status | Count | Percentage (%) |
|---|---|---|
| Growth Present | 34 | 28.33 percent |
| No Growth | 86 | 71.66 percent |




**Graph 1:** Culture findings




**Graph 2:** Bacteriological profile

**Table 2:** Sensitivity

| Antibiotics | Organism | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | C | E | EC | PV | AB | EA | K | A | CK | CNS | ECS | SA | MRSA |
| Amikacin | 8 | | | 3 | | 1 | 2 | 3 | | | | | | |
| Gentamycin | 6 | | | 4 | | 1 | | 3 | | | 8 | | 2 | |
| Colistin | | | | | | | | | | | | | | |
| Ceftazidime | 2 | | | | | | | 2 | | | | | 1 | |
| Ciprofloxacin | 2 | | | 1 | | | | 3 | | | 9 | | 1 | |
| Norfloxacin | | | | | | | | 1 | | | | | | |
| Levofloxacin | 4 | | | 1 | | | | 3 | | | 5 | | | |
| Trimethhopri m/Sulfametho xazole | 2 | | | | | | | | | | 3 | | | 1 |
| Piperacillin/Ta zabactam | 2 | | | | | 1 | 2 | 2 | | | | | | |
| Tigecycline | | | | 1 | | | 1 | | | | 1 | | 1 | |
| Amoxiclav | | | | 1 | | | | | | | | | | |
| Doripenem | 4 | | | 3 | | | 1 | 1 | | | | | 1 | |
| Meropenem | 4 | | | 3 | | | 3 | 4 | | | | | 1 | |
| Clindamycin | | | | | | | | | | | 1 | | | |
| Linezolid | | | | | | | | | | | 6 | | 1 | 1 |
| Teicoplanin | | | | | | | | | | | 5 | | | 1 |
| Vancomycin | | | | | | | | | | | 2 | | | 1 |
| Tetracycline | | | | | | | | | | | 2 | | | 1 |
| Ceftazidime | 2 | | | | | | | 1 | | | | | | |

**Discussion**

Renal stone disease, also known as nephrolithiasis, is a common condition that affects millions of people globally, with significant health and economic consequences. Among the many aspects of renal stone

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formation and management, understanding the culture and sensitivity of these stones plays a crucial role in effective diagnosis and treatment, particularly in patients suffering from recurrent infections or stone formation. The culture and sensitivity of renal stones provide valuable insights into the microbial organisms that may either contribute to stone formation or develop as a result of it.

**Role of Bacteria in Renal Stone Formation**

Renal stones are often described as "tombstones for bacteria," highlighting the association between bacteria and stone formation. Bacteria, particularly urease-producing ones, can cause the formation of struvite stones by raising the pH of urine. Struvite stones, composed of magnesium ammonium phosphate, are directly linked to urinary tract infections (UTIs) caused by organisms such as Proteus mirabilis, Klebsiella pneumoniae, and Pseudomonas aeruginosa [16, 17]. These bacteria generate urease, an enzyme that hydrolyzes urea into ammonia and carbon dioxide, resulting in alkaline urine, which precipitates the formation of crystals that aggregate into stones.

The presence of bacteria within renal stones poses significant challenges to treatment. While antibiotics are routinely used to treat UTIs, the internalization of bacteria within the stone matrix makes it difficult for antibiotics to effectively eradicate the infection. This often results in persistent infections or recurrent UTIs, even after antibiotic therapy, until the stone is surgically removed.

**Importance of Stone Culture and Sensitivity Testing**

The culture and sensitivity testing of renal stones is crucial for determining the most effective antibiotics to use in treating associated infections. During surgical procedures stone fragments are retrieved and sent for culture and sensitivity analysis. The results of these tests reveal whether bacterial organisms are present within the stones and, if so, which antibiotics they are susceptible or resistant to.

The findings from culture and sensitivity tests are important for both immediate and long-term patient care. For example, if the stone culture is positive for bacteria, post-operative antibiotic therapy can be tailored based on the specific organisms present and their sensitivity profiles. This personalized approach ensures that the patient receives the most effective treatment, reducing the likelihood of recurrent infections and promoting faster recovery.

In cases where antibiotic resistance is identified, such as with Extended-Spectrum Beta-Lactamase (ESBL)-producing bacteria, alternative antibiotics or combination therapies may be required to effectively manage the infection. The increasing prevalence of antibiotic-resistant strains highlights the importance of timely and accurate sensitivity testing in guiding treatment decisions.

**Clinical Implications**

The clinical implications of culture and sensitivity testing in renal stone management are significant. It not only helps in the selection of appropriate antibiotics but also provides insight into the possible origins of stone formation. In patients with recurrent stone disease or persistent infections, identifying the bacterial organisms involved can help guide both surgical and medical management strategies. Moreover, culture and sensitivity testing allows clinicians to adopt a more evidence-based approach, reducing the risks of treatment failure, antibiotic resistance, and unnecessary interventions.

**Conclusion**

In conclusion, culture and sensitivity testing of renal stones is a valuable tool in the management of nephrolithiasis, particularly in patients with recurrent or complicated infections. By identifying the bacterial organisms within the stones and determining their antibiotic susceptibility, clinicians can provide targeted treatment, improve patient outcomes, and reduce the risk of recurrence. As antibiotic resistance continues to rise, such testing becomes even more critical in ensuring the effective treatment of renal stone-associated infections. Moreover, the results of these tests offer insights into the complex relationship between bacterial infections and stone formation, paving the way for further research into the prevention and management of nephrolithiasis.

**Conflict of interest:** None.

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