Brawijaya Journal of Urology
November 2025, Volume 6, Issue 2
p-ISSN: 2721-4982 **e-ISSN**: 2722-4546
DOI: doi: 10.11594/bjurology.2025.006.02.4

Patient Profile and Treatment Selection in Urolithiasis in Tertiary Hospital: A Retrospective Analysis

Camilla Amanda[1]*, Besut Daryanto[1]

[1]*Department of Urology, Faculty of Medicine, Universitas Brawijaya, Dr. Saiful Anwar General Hospital, Malang, East Java, Indonesia, 65112*

***Corresponding Author**
Camilla Amanda
Department of Urology, Faculty of Medicine, Universitas Brawijaya, Dr. Saiful Anwar General Hospital, Malang, East Java, Indonesia, 65112
Email: camillamanda59@gmail.com

Introduction. Urolithiasis remains a prevalent urological disorder, often leading to significant morbidity, burden and a high rate of recurrence . Multiple factors, including age, sex, stone location, imaging characteristics, urinalysis parameters, and urine culture findings, could play crucial roles in guiding therapeutic decisions. This study aims to analyze the relationships between urine pH, urine culture results, stone location and the selection of surgical interventions and stone compositions in patients diagnosed with urinary stones at Dr. Saiful Anwar General Hospital, Malang.
Methods. This retrospective study utilized medical records of patients diagnosed with urolithiasis in Dr. Saiful Anwar General Hospital between 2018 and 2024. The collected data included age, sex, stone location (renal, ureteral, vesical), stone image in NCCT, urinalysis parameters (pH, erythrocyte), urine culture results, stone composition, and surgical intervention. Descriptive analysis was conducted to characterize patient demographics and clinical profiles, while further statistical evaluation was performed to assess relationship between factors that determined stone composition and treatment selection using Chi Square or Fischer's Exact Test.
Results. A total of 343 patients with urolithiasis met the inclusion criteria, among them, 71.1% were male with mean age of 52.75 ± 17.18 years, and 88.95% presented hematuria. The most common stone composition was mixed calcium and MAP (33.8%), most frequently presenting at multiple locations (45.1%). 311 patients had endourological procedures, PCNL (61.5%) as the management of choice. However, open surgery has been done in 22 (6.41%) patients with open surgery, most of whom have various locations of urolithiasis (59.0%). The results showed a significant relationship between stone location and treatment options ($p < 0.001$). In addition, there was a significant relationship between pH, urine culture and stone composition ($p = 0.018$; 0.034).
Conclusion. This study highlights that stone locations serve as valuable indicators in determining treatment strategies for urolithiasis patients. In addition, pH and urine culture serve as valuable indicators in determining stone composition. Further analysis is warranted to explore causal relationships between these factors and refine predictive models for personalized stone management.

Keywords: stone composition, treatment, urinary stone disease, urolithiasis

Introduction

Urolithiasis remains a common urological disorder, affecting approximately 106 million individuals globally in 2021. The prevalence ranges from 5-15% worldwide and 1-19.1% in the Asian population . Male individuals had a higher risk of urolithiasis than women [1-2]. The mortality rate of urolithiasis is generally (< 0.5%), but increased markedly with sepsis, reaching up to 8.8% [1,3]. In 2021, urolithiasis accounted for approximately 694,000 disability-adjusted life years (DALYs), representing a 34.5% increase since 2000. The recurrence rate ranges from 10–23% annually, reaching 50% within 5–10 years and 75% within 20 years in patients without preventive measures (metaphylaxis) [1-2].

Based on previous studies, the main underlying compositions are calcium oxalate stones and calcium phosphate stones at around 80%. Stones with struvite, uric acid and cystine composition account for 10%, 9% and 1%. Indication of active stone removal was Stone diameter is > 7 mm (low rate of spontaneous passage), Adequate pain relief cannot be achieved, Stone obstruction is associated with infection, Risk of pyonephrosis or urosepsis, Kidney obstruction [4].

Various factors, including age, gender, stone location, imaging characteristics, urinalysis parameters, and urine culture findings, play an important role in determining stone composition and guiding therapeutic decisions. Based on previous studies, Retrograde Intrarenal Surgery (RIRS) is still the preferred management of kidney stones compared to Shockwave Lithotriopsy (SWL), and Percutaneous Nephrolithotomy (PCNL) [5]. RIRS is also reported to have higher stone-free rates (SFRs) and lower invasive rates than PCNL [6-7]. PCNL is performed on larger stones (>2 cm) while RIRS with SWL is preferred for <2cm [7]. This study aims to analyze the relationships between urine pH, urine culture results, stone location and the selection of surgical interventions and stone compositions in patients diagnosed with urinary stones at tertiary hospital in Indonesia.

Materials and Method

This retrospective study used a descriptive and analytical approach. The subjects were patients diagnosed with urolithiasis who underwent surgical treatment between 2018 and 2024 in Saiful Anwar General Hospital. Inclusion criteria included all patients diagnosed with urolithiasis who received surgical intervention during the study period. Patients with incomplete medical records were excluded.

The data that could be used was age, gender, stone location (kidney, ureter, vesica, or urethra), stone image in NCCT, urinalysis parameters (pH, leukocytes), urine culture results, and stone composition. Management of each diagnosis was also collected as treatment selections were percutaneous nephrolithotomy (PCNL), Ureteroscopy (URS), and Vesicolithotripsy. The statistical analysis required the use of software SPSS 25. The comparison between the frequencies was carried out using the chi-squared and Fisher's exact test with p-value <0.05 was considered significant.

Descriptive analysis was conducted to characterize patient demographics and clinical profiles, while further statistical evaluation was performed to assess correlation between factors that determined stone composition and treatment selection using Chi Square or Fischer's Exact Test. This study was approved by the Health Research Ethic Commission of Dr. Saiful Anwar General Hospital with ethical number: 400/084/K.3/102.7/2025.

Result

Based on the description of Table 1, the characteristics of 343 subjects have an average age of 52.75 ± 17.18 years old. The majority of the subjects were between 41 – 60 years old (47.2%). Most of the subjects were male (71.1%). The majority of subjects had mixed calcium and Magnesium Ammonium Phosphate (MAP) stone (33.8%), and presented multiple locations (45.1%). The majority of the subjects underwent Percutaneous Nephrolithotomy (PCNL) (61.5%). For more details, see the table below.

Table 1. Characteristics of Urolithiasis Patients

Characteristics	Frequency (%)	Mean ± SD
Age		
<20 years	21 (6.1)	52.75 ± 17.18
20 – 40 years	35 (10.2)	
41 – 60 years	162 (47.2)	
>60 years	125 (36.4)	
Sex		
Male	244 (71.1)	
Female	99 (28.9)	
Stone Composition		
Calcium	76 (22.2)	
Calcium + MAP	116 (33.8)	
Ca + MAP + uric acid	13 (3.8)	
MAP	45 (13.1)	
Unspecified	56 (16.3)	
Uric acid	37 (10.8)	
pH		6.14 ± 0.96
Erithrocyte		466.71 ± 1431.24
Stone Location		
Renal	145 (42.3)	
Ureter	34 (9.9)	
Bladder	9 (2.6)	

Characteristics	Frequency (%)	Mean ± SD
Multiple	155 (45.1)	
Treatment		
PCNL	211 (61.5)	
RIRS	27 (7.9)	
ECIRS	15 (4.4)	
URS	59 (17.2)	
Vesicolithotripsy	9 (2.6)	
Open renal	15 (4.4)	
Open Ureter	3 (0.9)	
Open bladder	4 (1.2)	

As shown in Table 2, stone composition varied across age and sex groups. The majority were 41–60 years old in each stone composition group, with the majority of the patients were male. For more details, see the table below.

As shown in Table 3, patients have undergone various treatments across age and sex groups. The majority were 41-60 years old in each treatment group, with the majority of the patients were male. PCNL mostly done in renal and multiple stone locations (30.3%). Retrograde Intrarenal Surgery (RIRS) mostly done in renal stone locations, Endoscopic Combined Intrarenal Surgery (ECIRS) mostly done in multiple stone locations, URS mostly done in ureter locations, vesicolithotripsy mostly done in bladder location, open renal mostly done in renal location (Table 3).

Table 2. Patients Demography based on Stone Composition

Characteristics	Stone Composition					
	Calcium (%)	Calcium + MAP (%)	Ca + MAP + uric acid (%)	MAP (%)	Unspecified (%)	Uric acid (%)
Age						
<20 years	9 (2.6)	7 (2.0)	1 (0.3)	0 (0)	0 (0)	4 (2.3)
20 – 40 years	11 (3.2)	14 (4.1)	0 (0)	1 (0.3)	4 (1.2)	5 (3.8)
41 – 60 years	31 (9.0)	51 (14.9)	8 (2.3)	24 (7.0)	32 (9.3)	16 (17.5)
>60 years	25 (7.3)	44 (12.8)	4 (1.2)	20 (5.8)	20 (5.8)	12 (13.5)
Sex						
Male	56 (16.3)	86 (25.1)	11 (3.2)	25 (7.3)	45 (39.8)	21 (26.3)
Female	20 (5.8)	30 (8.7)	2 (0.6)	20 (5.8)	11 (16.2)	16 (10.7)

Chi-square test and Fisher's exact test were performed to assess the association between stone composition and urine pH, urine culture, NCCT findings, and stone location. The Chi-square test revealed a statistically significant association between stone composition and urine pH ($p = 0.018$) as well as urine culture ($p = 0.034$). In contrast, Fisher's exact test showed no statistically significant association between stone composition and NCCT findings ($p = 0.117$) or stone location ($p = 0.259$) (Table 4).

Fisher's exact test was performed to evaluate the association between treatment strategies and stone location, stone composition, NCCT findings, urine culture, and urine pH. The analysis demonstrated a statistically significant association between treatment strategies and stone location ($p < 0.001$). However, no significant associations were found between treatment strategies and stone composition ($p = 0.058$), NCCT findings ($p = 0.478$), urine culture ($p = 0.583$), or urine pH ($p = 0.586$) (Table 5).

There was no significant relationship between categorized diagnosis and open surgery with a p value of 0.543. It might be caused by a lot of other factors to consider as the reason for the operator to choose open surgery (Table 6).

Discussion

In this study, the most common stone composition was calcium stones with MAP (magnesium ammonium phosphate). Stone composition analysis is useful in providing insights into the pathogenesis and underlying conditions of urolithiasis. The most prevalent stone components were calcium oxalate (63%), uric acid (11%), and carbonate apatite (11%)9. According to a study conducted by the majority of urinary tract stones

Table 3. Patients Demography based on Treatment

Characteristics	Treatment							
	PCNL	RIRS	ECIRS	URS	Vesicolithotripsy	Open renal	Open Ureter	Open bladder
Age								
<20 years	11 (3.2)	2 (0.6)	1 (0.3)	4 (1.2)	1 (0.3)	1 (0.3)	0 (0)	1 (0.3)
20 – 40 years	22 (6.4)	5 (1.5)	0 (0)	6 (1.7)	1 (0.3)	0 (0)	1 (0.3)	0 (0)
41 – 60 years	105 (30.6)	11 (3.2)	9 (2.3)	25 (7.3)	5 (1.5)	6 (1.7)	1 (0.3)	1 (0.3)
>60 years	73 (21.3)	9 (2.6)	6 (1.7)	24 (7.0)	2 (0.6)	8 (2.3)	1 (0.3)	2 (0.6)
Sex								
Male	143 (41.7)	22 (6.4)	14 (4.1)	40 (11.7)	7 (2)	11 (3.2)	3 (0.9)	4 (1.2)
Female	68 (19.8)	5 (1.5)	1 (0.3)	19 (5.5)	2 (0.6)	4 (1.2)	0 (0)	0 (0)
Location								
Renal	104 (30.3)	16 (4.7)	3 (0.9)	13 (3.8)	1 (0.3)	8 (2.3)	1 (0.3)	1 (0.3)
Ureter	3 (0.9)	0 (0)	0 (0)	33 (9.6)	0 (0)	0 (0)	1 (0.3)	1 (0.3)
Bladder	0 (0)	0 (0)	0 (0)	0 (0)	8 (2.3)	0 (0)	0 (0)	1 (0.3)
Multiple	104 (30.3)	11 (3.2)	12 (3.5)	13 (3.8)	0 (0)	7 (2.0)	1 (0.3)	1 (0.3)

Table 4. Relationship Between Stone Composition and Urine pH, Urine Culture, NCCT Findings, and Stone Location

Characteristics	Stone Composition						p-value
	Calcium	Calcium + MAP	Ca + MAP + uric acid	MAP	Unspecified	Uric acid	
pH							
<6	20	16	0	12	7	11	0.018*
≥6	56	100	13	33	49	26	
Urine Culture							
Sterile	61	81	11	33	39	35	0.034*
Bacteria	15	35	2	12	17	2	

Characteristics	Stone Composition						p-value
	Calcium	Calcium + MAP	Ca + MAP + uric acid	MAP	Unspecified	Uric acid	
NCCT							
Stone –	2	1	0	4	1	0	0.117**
Stone +	74	115	13	41	55	37	
Location							
Renal	30	48	4	15	28	22	0.259**
Ureter	7	13	0	5	9	4	
Bladder	2	2	0	3	1	1	
Multiple	37	53	9	22	18	10	

*Chi Square test
**Fischer's exact test

Table 5. Relationship Between Treatment Strategies and Stone Location, Stone Composition, NCCT Findings, Urine Culture, and Urine pH

Characteristics	Treatment								p- value
	PCNL	RIRS	ECIRS	URS	Vesicolitho tripsy	Open renal	Open Ureter	Open bladder	
Location									
Renal	104	16	3	13	1	8	1	1	<0.001*
Ureter	3	0	0	33	0	0	1	1	
Bladder	0	0	0	0	8	0	0	1	
Multiple	104	11	12	13	0	7	1	1	
Stone composition									
Ca	51	6	3	10	3	1	1	1	0.058*
Ca + MAP	77	10	6	15	1	4	0	3	
Ca + MAP + uric acid	6	3	2	1	0	1	0	0	
MAP	27	1	0	8	3	5	1	0	
Unspecified	32	3	2	15	1	3	0	0	
Uric acid	18	4	2	10	1	1	0	0	

Characteristics	Treatment								p- value
	PCNL	RIRS	ECIRS	URS	Vesicolitho tripsy	Open renal	Open Ureter	Open bladder	
NCCT									
Stone –	4	0	0	4	0	0	0	0	0.478*
Stone +	207	27	15	55	9	15	3	4	
Urine Culture									
Sterile	158	22	12	47	5	11	3	2	0.583*
Bacteria	53	5	3	12	4	4	0	2	
pH									
<6	39	5	0	17	1	4	1	0	0.586*
≥6	172	22	15	42	8	11	2	4	

*Fischer's exact test

Table 6. Frequent diagnosis in open surgery

Treatment	Diagnosis			p-value
	Cancer n (%)	Abscess n (%)	Multiple n (%)	
Open renal	4 (26.7)	4 (26.7)	7 (46.7)	0.543
Open Ureter	1 (33.3)	1 (33.3)	1 (33.3)	
Open bladder	0 (0)	0 (0)	4 (100)	

consist of two components (50.9%), followed by single-component stones (27.1%) and three-component stones (21.9%). Mixed-composition stones can present diagnostic and therapeutic challenges. The most frequent mixed components were calcium oxalate monohydrate with calcium oxalate dihydrate (63.8%), followed by calcium oxalate dihydrate with carbonate apatite (15.6%) [8].

This study demonstrated a significant association between stone composition and both urine pH and urine culture. According to [9], the primary risk factors for stone formation—particularly those composed predominantly of calcium oxalate and calcium phosphate—are elevated calcium levels and low urine pH. The formation of calcium oxalate stones is influenced by urine pH and environmental factors, making treatment and prevention closely related to metabolic regulation. Low urinary citrate levels can alter urine pH, preventing the formation of soluble calcium-citrate complexes and thereby promoting stone formation [10]. In addition, positive urine cultures with urease-producing bacteria have been associated with struvite stone formation, accounting for approximately 7–8% of all urinary stones. This occurs due to increased ammonia production as a result of bacterial urease activity [9].

Stone composition was not significantly associated with stone location. A previous study reported that calcium oxalate stones are more commonly found in the kidneys than in the urinary bladder, whereas uric acid stones are generally found in the lower urinary tract. This study also noted that bladder stones are often associated with nutritional deficiencies, lower urinary tract obstruction, and infections. Consequently, uric acid and struvite stones are more frequently identified in the bladder. However, no significant differences in stone composition were observed between the kidney and ureter, or between the urethra and bladder [11].

Management strategies are tailored to each patient based on stone size, composition, location, and underlying metabolic conditions. Surgical intervention plays a crucial role, while pharmacological therapy is essential for preventing recurrence and regulating the metabolic processes involved in stone formation. Surgical approaches include ESWL, URS, high-intensity focused ultrasound (HIFU), PCNL, open surgery, laparoscopy, and combined modalities such as ECIRS [12].

This study demonstrated that treatment selection was associated with stone location. ESWL is more effective for renal and proximal ureteral stones measuring less than 2 cm. URS is effective for renal and ureteral stones smaller than 1 cm, particularly those located in the renal calyces and renal pelvis, which require endoscopic visualization. PCNL is considered the gold standard for stones larger than 2 cm or complex staghorn calculi. Open surgery and laparoscopy are reserved for cases involving complex anatomical abnormalities [12].

Even the composition of stones could not be a determining factor of choosing treatment in urinalysis, it still be useful for prevention and diet as risk management [4,6]. Stone location is one of the most determining factors for choosing treatment in urolithiasis, in tertiary hospitals which is the highest healthcare and last referral that provide advanced specialized medical care in Indonesia [7]. Open surgery still has its roles in complex stone disease, anatomical and physiological anomalies. As in this study non-urological comorbidities such as abscesses and malignancies also influenced the choice of open surgery, in this case are abscess and cancer [5].

Conclusion

Stone locations serve as valuable indicators in determining treatment strategies for urolithiasis patients, pH and urine culture serve as valuable indicators in determining stone composition. Further analysis is warranted to explore causal relationships between these factors and refine predictive models for personalized stone management.

Conflict of Interest

The authors declare no conflict of interest.

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