

Changes in Ureteral Stone Treatment During COVID-19: A Single-Center Emergency Department Study

Adrian Militaru^{1,2}, Catalin Andrei Bulai^{1,2}, Cosmin Victor Ene^{1,2}, Razvan Ionut Popescu^{1,3}, Cristian Mares^{1,2}, Stefan Marian Balacescu^{1,2}, Razvan Dragos Multescu^{1,2}, Dragos Adrian Georgescu^{1,2}, Petrisor Aurelian Geavlete^{1,2}, Bogdan Florin Geavlete^{1,2}

¹Department of Urology, “Carol Davila” University of Medicine and Pharmacy, Bucharest, Romania; ²Department of Urology, “Saint John” Clinical Emergency Hospital, Bucharest, Romania; ³Department of Urology, “Prof. Dr. Th. Burghel” Clinical Hospital, Bucharest, Romania

Correspondence: Catalin Andrei Bulai, Department of Urology, “Saint John” Clinical Emergency Hospital, 13 Vitan-Barzesti str, Bucharest, 042122, Romania, Tel +40749184205, Email catalin.bulai@umfcd.ro

Purpose: We evaluated the hospitalization rate, length of stay, and management of patients with ureteric lithiasis admitted under emergency conditions at a single institution during the COVID-19 pandemic.

Patients and Methods: A retrospective study was conducted on 219 patients with ureteral lithiasis, divided into pre-COVID-19 (1.10.2019–29.02.2020) and COVID-19 groups (1.10.2020–29.02.2021). The study examined patient and stone characteristics, hospitalization duration, surgical interventions, creatinine levels, and associated urinary tract infections. It also evaluated the complications related to delayed treatment during the pandemic.

Results: The study found a 73.41% reduction in admissions for obstructive ureteral lithiasis during the COVID-19 pandemic compared to the pre-pandemic period. Notable differences were observed in age (61.5 vs 46 years, $p=0.000$), gender ($p=0.046$), stone laterality ($p=0.024$), location ($p=0.002$), serum creatinine levels (1.59 vs 1.09 mg/dL, $p=0.000$), and urine cultures (45.65% vs 23.12%, $p=0.002$). During the pandemic period, the rate of primary stone extraction procedures decreased (32.6% vs 59%, $p<0.001$), while operative time (52.89 vs 39.84 minutes, $p<0.001$) and hospital stay significantly increased (13.09 vs 3.76 days, $p<0.001$).

Conclusion: The pandemic resulted in fewer hospitalizations for ureteral lithiasis and an increase in complications, likely due to reduced access to medical care and a greater tendency for upper urinary tract drainage.

Keywords: COVID-19, urolithiasis, ureteroscopy, double J stent, ureteral stone, percutaneous nephrostomy

Introduction

The 2019 coronavirus disease (COVID-19) outbreak in China posed a significant threat to global health, which is by far the most significant case of atypical pneumonia since the 2003 outbreak of severe acute respiratory syndrome (SARS)¹. The source of this acute respiratory syndrome is SARS-CoV-2, a recently discovered β -coronavirus that first appeared in Wuhan, in December 2019, linked to zoonotic transmission and responsible for a global pandemic affecting millions worldwide across various sectors.² On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic, significantly impacting nearly every facet of daily life worldwide, particularly for hospitalized patients undergoing recovery.^{3,4} This situation reshaped healthcare delivery globally, presenting unprecedented challenges across medical specialties.

The index case of SARS-CoV-2 in Romania was identified on February 26, 2020, in an individual with a travel history to Italy.⁵ Amid the global challenges posed by the virus, healthcare systems swiftly adjusted to safeguard the well-being of patients and healthcare workers. Urological emergencies emerged as a critical focus during this period, highlighting the complex interplay between the pandemic and the field of urology.⁶ During the pandemic, Romania's healthcare system had approximately 6.5 hospital beds per 1000 people, with intensive care units experiencing significant

strain. These resources were unevenly distributed across regions, contributing to variability in patient outcomes during the COVID-19 crisis.⁷ The pandemic also placed substantial pressure on antimicrobial stewardship efforts, particularly in hospital settings, where increased antibiotic use led to a rise in antimicrobial resistance. Recent data from urological centers confirm this trend, highlighting a concerning prevalence of hospital-acquired infections and multidrug-resistant organisms during the pandemic.⁸

Urolithiasis, or kidney stone disease, is a common and often painful condition affecting millions worldwide.⁹ Characterized by the formation of solid masses within the urinary tract, nephrolithiasis can lead to intense pain, discomfort, and severe complications if left untreated.¹⁰ Studies indicate that urolithiasis affects an estimated 5–14% of the European population, a prevalence higher than in many other parts of the world. Recent evidence suggests an increasing prevalence, particularly in industrialized nations.¹¹ However, prevalence varies significantly by region: 1–5% in Asia, 5–9% in Europe, 13% in North America, and 20% in Saudi Arabia.¹² It impacts individuals of all ages, genders, and ethnicities^{13,14} but is more common in men aged 20–49 than women.¹⁵ Recent research has shown that the prevalence of nephrolithiasis has been on the rise in both industrialized and developing countries over the past few decades, even though novel treatments for urinary stone therapy have made great strides.¹⁶ This trend has been attributed to lifestyle changes, including reduced physical activity, dietary habits, and global climate change.^{14,17,18}

The impact of the COVID-19 pandemic on urolithiasis management is a critical issue that must be addressed comprehensively, encompassing both urgent and elective treatments. During the pandemic, healthcare systems worldwide faced delays in hospital admissions and increased complications, not only for ureteral lithiasis but also for other time-sensitive urological emergencies such as testicular torsion. This has led to potentially devastating consequences, as highlighted by a recent study showing a significant increase in orchiectomy rates and delayed emergency department presentations for testicular torsion during the pandemic.¹⁹ It is crucial to investigate the broader impact of the pandemic on urological care and to identify strategies to minimize delays and optimize patient outcomes. To prevent catastrophic consequences, we must improve our comprehension of the presentation and treatment of urolithiasis during pandemics.²⁰ Studies in the specialized literature have shown that ureteral stones smaller than 5 mm can be naturally expelled under conservative care.²¹ The use of medical expulsive therapy (MET) as a potential substitute for surgical therapies gained significant importance. However, in the acute management of renal colic, renal decompression remains a critical intervention for cases involving analgesic-resistant pain, concurrent uremia, anuria, or potentially life-threatening urosepsis.²²

Considering the COVID-19 pandemic, this study investigates the hospitalization rate, length of stay, and management strategies for patients presenting with the urological emergency of ureteric lithiasis at a single institution. The study aims to shed light on the impact of the pandemic on the management of this urgent condition and the potential complications arising from delayed treatment. The findings of this study have important implications for healthcare system planning and resource allocation during public health emergencies.

Materials and Methods

This study primarily aimed to evaluate the impact of the COVID-19 pandemic on emergency department admissions, hospitalization rates, and management strategies for ureteral stones at a single institution in Bucharest, Romania. Secondary objectives included assessing changes in patient demographics, stone characteristics, hospitalization duration, surgical interventions, and serum creatinine levels between the pre-pandemic and pandemic periods. The study also investigated shifts in treatment modalities, particularly the transition from primary stone extraction to upper urinary tract drainage procedures.

Patients and Ethical Aspects

After obtaining approval from the hospital's local ethics committee (No. 9420/ 19.04.2022), we conducted a unicentric retrospective study on patients presenting with the urological emergency of ureteral lithiasis, who were admitted through the emergency department. Consecutive patients aged 18 years or older with obstructive ureteral lithiasis pathology admitted as emergencies to the Urology clinic of the "Saint John" University Emergency Clinic Hospital in Bucharest were included in the study. Patients were assigned to two distinct groups based on the date of admission: a pre-COVID

-19 group (October 1, 2019 – February 29, 2020) and a COVID-19 group (October 1, 2020 – February 28, 2021), corresponding to the period when elective surgical procedures were suspended in our institution. During the COVID-19 period, we included adult patients (aged 18 years or older) who presented with obstructive ureteral lithiasis and tested positive for SARS-CoV-2 using RT-PCR upon admission. Patients were excluded from the study if they tested negative for COVID-19 during the pandemic period, were pregnant, had severe comorbidities necessitating multidisciplinary management, or had incomplete clinical or laboratory records that could compromise data integrity.

Study Design

We analyzed the characteristics of the two groups from the observation sheets, such as sex, age, Body Mass Index (BMI), laterality, and duration of hospitalization. We also examined the characteristics of the stones, such as location and size, the duration of hospitalization and surgical interventions, the type of intervention performed (ureteroscopy, insertion of a double J ureteral stent, or percutaneous nephrostomy), creatinine level, and the presence of an associated urinary tract infection.

Patient's Management

RT-PCR testing for SARS-CoV-2 was performed on hospitalized patients during the COVID-19 pandemic upon admission, using nasopharyngeal swabs as a sample. To mitigate the risk of COVID-19 transmission to medical personnel who interact with these patients, personal protective equipment (PPE) was utilized following the treatment guidelines for positive patients as established by the Ministry of Health. Additionally, the specific medications required for managing COVID-19 were administered in collaboration with infectious disease specialists, adhering to established treatment guidelines.

The initial imaging evaluation was done using ultrasonography, followed by a computed tomography examination to confirm the diagnosis and determine the position and dimensions of the stones. When semi-rigid ureteroscopy (URS) was performed, we used ballistic and laser lithotripsy to disintegrate the stones. In acute settings, percutaneous nephrostomy was preferred for patients with severe infections or septic presentations, as it provides more effective and immediate decompression of the urinary system. Double J stents were used in cases where infection was less severe or when local anesthesia was the preferred approach.

Statistical Analysis

Continuous variables were assessed for normality using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Normally distributed continuous variables are presented as mean (\pm) standard deviation and were compared using the Student's *t*-test. Non-normally distributed continuous variables are presented as median (interquartile range) and were compared using the Mann–Whitney *U*-test. Categorical variables are presented as frequencies and percentages and were compared using the Chi-square or Fisher's exact test, as appropriate. A *p*-value < 0.05 was considered statistically significant. All data were analyzed using SPSS version 20 (IBM Corp, Armonk, NY, USA).

Results

This study analyzed 219 patients hospitalized in the Urology Clinic of the Saint John Emergency Hospital, Bucharest. The key characteristics of the study participants are summarized in [Table 1](#). Remarkably, 73.41% fewer patients were admitted to the urology clinic in the emergency regime for obstructive ureteral lithiasis in the COVID-19 cohort than in the pre-COVID-19 era (46 vs 173). The median age differed significantly between the pre-pandemic period and the COVID-19 period, with values of 46 and 61.5 years, respectively ($p=0.000$).

Additionally, there were gender differences ($p=0.046$), laterality of the stones ($p=0.024$), the location at the ureteral level ($p=0.002$), and the serum creatinine level (1.09 vs 1.59, $p=0.000$). Patients presenting during the COVID-19 period exhibited higher rates of positive urine cultures (45.65% vs 23.12%, $p=0.002$), which correlated with increased septic presentations and infectious complications. No significant differences were found regarding the body mass index between the two cohorts (26.8 vs 26.75, $p=0.340$) and the diameter of the stones (9 vs 9, $p=0.263$).

Table 1 Characteristics Between the Pre-Pandemic and the Pandemic Patient Cohort

ED Admissions	Pre COVID-19 Period	COVID-19 Period	p-value
No	173	46	
Sex			
Male	72 (41.6%)	27 (58.7%)	0.046 ^c
Female	101 (58.4%)	19 (41.3%)	
Age	46	61.5	0.000 ^a
BMI (kg/m ²)	26.8	26.75	0.340 ^a
Stone side			
L	71 (41.05%)	29 (63.04%)	0.024 ^c
R	84 (48.55%)	13 (28.26%)	
Bilateral	18 (10.4%)	4 (8.69%)	
Stone size	9	9	0.263 ^a
Stone location			
Upper ureter	70 (40.5%)	26 (56.52%)	0.002 ^c
Midureter	38 (22%)	15 (32.61%)	
Distal ureter	65 (37.5%)	5 (10.87%)	
Creatinine (mg/dL)	1.09	1.59	0.000 ^a
Positive urine culture >105 CFU	40 (23.12%)	21 (45.65%)	0.002 ^c
Duration of hospital stay (days)	3.76 ± 1.814	13.09 ± 9.203	<0.001 ^b

Notes: ^aU-test; ^bT-test; ^cChi-square test.

Abbreviations: ED, Emergency Department; BMI, Body Mass Index; No, Number; CFU, Colony-Forming Unit.

Our observations revealed a significant shift in managing hospitalized patients presenting with urological emergencies during the pandemic. Notably, there was a substantial decrease in the number of cases receiving primary stone extraction treatment (102 vs 15, $p=0.001$) (Table 2), this coincided with a rise in the use of upper urinary tract drainage techniques like double-J stents and percutaneous nephrostomy (Figure 1). Additionally, an increase in operating time (39.84 ± 13.689 minutes pre-pandemic versus 52.89 ± 9.664 in pandemic, $p<0.001$) and length of stay in days (3.76 ± 1.814 vs 13.09 ± 9.203 , $p<0.001$) was noted (Figure 2).

Table 2 Management of Ureteral Stones

Type of Intervention	Pre COVID-19 Period	COVID-19 Period	p-value
Double J insertion	67 (38.7%)	26 (56.5%)	0.001 ^b
URS	102 (59%)	15 (32.6%)	
Nephrostomy	4 (2.3%)	5 (10.9%)	
Surgery time (min)	39.84 ± 13.689	52.89 ± 9.664	<0.001 ^a
Duration of hospital stay (days)	3.76 ± 1.814	13.09 ± 9.203	<0.001 ^a

Notes: ^aT-test; ^bChi-square test.

Abbreviation: URS, Ureteroscopy.

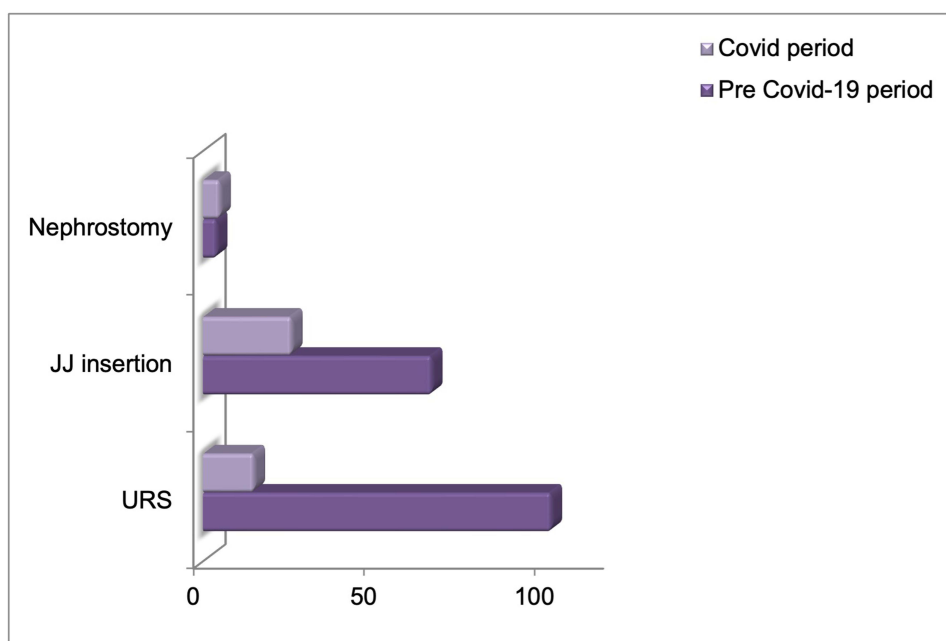


Figure 1 Management of hospitalized patients during the pre-pandemic and the pandemic periods.

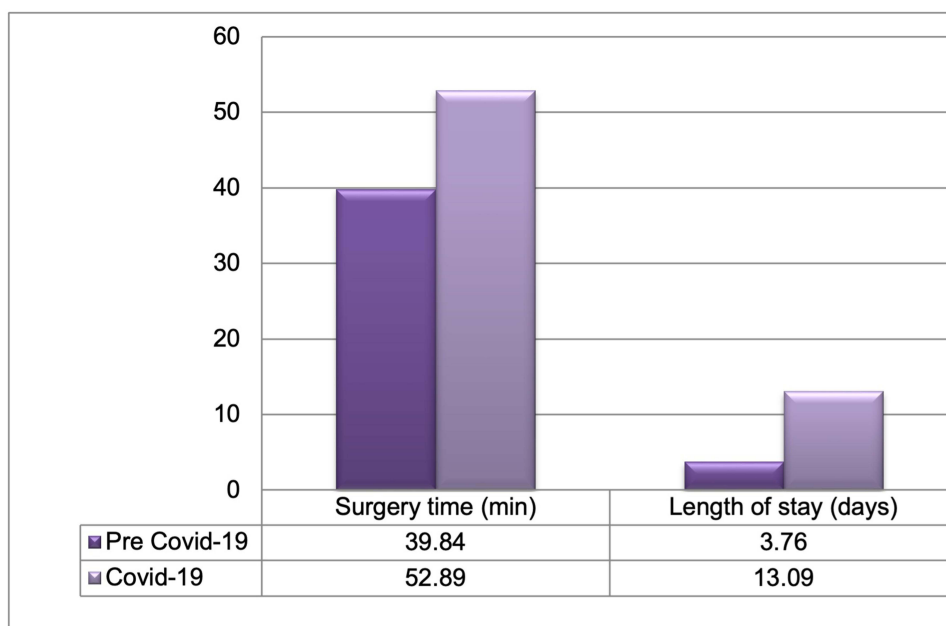


Figure 2 Management characteristics during the pre-pandemic and the pandemic periods.

Discussion

The COVID-19 pandemic posed significant challenges to urology, as well as to other medical specialties. This led to a substantial reduction in elective surgeries and ambulatory care, as hospital resources were frequently redirected to critical COVID-19 services. Although numerous urological associations issued guidelines for managing such conditions, few studies in our country have evaluated the practical implications of these recommendations during the pandemic.^{23,24} This study aimed to assess the impact of the COVID-19 pandemic on emergency department (ED) admissions, hospitalizations, and treatment strategies for patients presenting with obstructive ureteral lithiasis at our institution. We

aimed to understand how the pandemic affected the management of this urgent condition and the potential complications that arose due to treatment delays. The COVID-19 pandemic significantly affected patient recruitment, resulting in a notably smaller sample size in the COVID-19 period group. This disparity in group sizes may limit the statistical power and generalizability of the findings for this group. However, to mitigate these concerns, we focus on the effect sizes observed, as a large effect size can still be clinically meaningful even with a smaller sample.

When the COVID-19 pandemic was in its early stages, the EAU Urolithiasis Guidelines panel issued a sheet of evidence-based recommendations for treating urinary stone disorders. This recommendation sheet identifies several conditions as critical or emergencies requiring immediate attention, including renal failure, acute flank pain, obstructing or symptomatic ureteral stones that are not amenable to MET, renal stones with recurring infections and obstructions, sepsis and anuria caused by obstructing stones.^{22,25} In response to the COVID-19 epidemic, methods have been developed to prioritize and triage people with urological diseases. Conservative therapy was part of the plan, as was the use of local anesthesia to reduce the need for ventilators and the likelihood of contracting COVID-19. Based on individual variables such as symptomatology, comorbidities, and stone-related complications such as degree of obstruction, coexistence of a urinary tract infection, and failure of conservative care, surgical priority was determined when recommended operational management. Our approach aligns with the recommendations of Yasserli and Aghamir, who advocate for the use of medical expulsive therapy (MET) in appropriate cases to manage urolithiasis during the COVID-19 pandemic. This strategy aims to minimize the demand for surgical interventions and reduce patient exposure to healthcare settings, thereby conserving medical resources and lowering the risk of COVID-19 transmission.²⁶ Outpatient procedures, such as stent placement under local anesthesia (LA) and shockwave lithotripsy (SWL), played a vital role in managing select cases during the pandemic. These approaches helped reduce the strain on inpatient services while ensuring timely intervention for non-emergency cases. According to several publications, the first intention to drain an infected and blocked system is the placement of a double J ureteral stent under local anesthesia, and nephrostomy is the second line of treatment.^{23,27,28} The delay in definitive treatment likely contributed to the observed increase in complications, such as elevated serum creatinine levels (indicative of potential kidney injury) and a higher incidence of urinary tract infections. During the COVID-19 period, the substitution of JJ stents was frequently delayed due to resource constraints. Prolonged stent use increased the risk of encrustation and infection, underscoring the challenges faced in ensuring timely definitive treatment.

These observations correspond closely with the findings reported by Carrion et al, who reported a significant reduction in emergency department visits for renal colic during the COVID-19 pandemic. They attributed this decline to patients' fear of contracting COVID-19 in healthcare settings and the reallocation of medical resources to pandemic-related care. This underscores the broader impact of the pandemic on patients' healthcare-seeking behaviors and the management of urological emergencies.²⁹

Our findings are consistent with the study by Kaczmarek et al, conducted in Poland, which reported a significant reduction in hospitalizations for renal colic during the COVID-19 pandemic compared to the pre-pandemic period. That study observed a decrease of up to 56.41% in hospital admissions for renal colic, attributed to the surge in COVID-19 cases and associated healthcare constraints.³⁰

Operative times in urology and other surgical specialties were prolonged throughout the COVID-19 pandemic due to the utilization of PPE. The primary causes for this extension in operative time were the implementation of enhanced infection control protocols and the additional steps required for donning and doffing PPE. Although essential for safeguarding healthcare personnel and patients, these precautions unavoidably increased preoperative and postoperative durations, consequently lengthening overall surgical times.³¹ Also, in our study, a significant increase in operating times was observed due to using of PPE, stricter protocols, and potentially reduced team sizes. Also, the observed extended hospital stay during the COVID-19 period can be attributed to the concurrent management of COVID-19 pathologies and adherence to national isolation protocols.

The therapeutic management of the patients in our study was significantly different between the two groups, comparable to Gul et al, where more patients (37.2% vs 0.9%) from a Turkish hospital between March and June 2020 who had ureteral stones received nephrostomy tubes.²⁵ Compared to the non-COVID period, when ureteroscopy was the main form of definitive treatment for ureteral stones in our center, the rate of minimally invasive procedures, which

included percutaneous nephrostomy and double J stent placement, was significantly greater in the group of patients in the COVID-19 period.

Other studies in the specialized literature have reported a decline in the number of urological patients presenting with kidney stones.^{4,32} A recent large multicenter study by Mazzon et al involving over 4,000 patients further supports this trend, documenting reduced access to definitive treatment and increased reliance on temporizing procedures during the COVID-19 pandemic.³³ Starting from these results, we assumed that the patients presented themselves later at the hospital, enduring a more extended period of suffering caused by renal colic. The higher rates of positive urine cultures and associated septic complications during the COVID-19 period can be attributed to delays in seeking care. These findings underscore the critical importance of timely intervention in urological emergencies to prevent severe outcomes. Spooner et al reported an increase in septic and febrile presentations of kidney stones during the COVID-19 pandemic. They attributed this trend to reduced access to timely care due to pandemic restrictions, which likely led to delayed treatment and worsened clinical outcomes. These findings underscore the broader implications of healthcare access limitations during crises.³⁴ The limited availability of intensive care unit (ICU) beds in Romania, coupled with regional disparities in healthcare resources, likely exacerbated delays in the treatment of urological emergencies during the pandemic. This aligns with studies highlighting the negative correlation between ICU capacity and health outcomes during the COVID-19 period.³⁵

The higher serum creatinine levels in the COVID-19 group suggest potential kidney injury due to prolonged obstruction. Additionally, the increased incidence of urinary tract infections may be attributed to delayed treatment, allowing bacterial colonization and ascending infection. Several factors likely contributed to the observed delay in seeking medical attention. These include government-imposed restrictions, such as stay-at-home orders and limitations on non-essential travel. Additionally, public fear of contracting COVID-19, potentially amplified by media coverage, may have deterred individuals from presenting to healthcare facilities.³⁶ This seems to be reflected in higher serum creatinine levels in patients from the COVID-19 period compared to the pre-pandemic era, as shown by Flammia et al.³⁷ Our findings align with these observations, as well as regarding the statistically insignificant difference related to the average size of the stones. In addition, we also observed a higher rate of percutaneous nephrostomies, like the results of the study by Gul et al, where the rate was higher in the group of 35 patients from the Covid period compared to the 114 from the pre-Covid era.²⁴ However, our data regarding urinary tract infection rates and serum creatinine levels differ from those reported by Byrne et al,²⁸ Anderson et al,³⁸ and Nourian et al,³⁹ who found no significant changes in these factors between Covid-19 group period and the pre-pandemic era.

The introduction of COVID-19 vaccination programs in 2021 played a pivotal role in restoring normal urological activities at our center. As vaccination coverage increased, there was a noticeable improvement in patient confidence to seek care, which had been significantly impacted during the earlier stages of the pandemic. This facilitated the resumption of elective surgeries and other routine urological services that had been postponed due to the overwhelming focus on pandemic management. Porreca et al (2021) highlighted how the vaccination campaign helped alleviate the strain on healthcare systems, enabling the safe reinstatement of urological procedures. Their findings are consistent with our observations, where vaccination programs not only reduced COVID-19 case numbers but also mitigated fears surrounding hospital visits, thereby improving healthcare accessibility and efficiency.⁴⁰ Moreover, the safety profile of COVID-19 vaccines in patients with urological conditions, such as kidney stones and urinary tract infections, has been extensively studied. Carr et al (2021) conducted a systematic review demonstrating that COVID-19 vaccines are both safe and effective in individuals with kidney-related conditions, with no significant increase in adverse events.⁴¹ This aligns with our findings, as no safety concerns related to vaccination were noted in our cohort. The absence of vaccine-related complications in these patients underscores the importance of widespread vaccination to ensure the continuity of routine medical care and elective surgical interventions.

It is important to note that this study has certain limitations. First, its retrospective design, which may introduce inherent biases. Second, we must mention the study's single-center nature with a relatively small sample size. Furthermore, we acknowledge the potential limitations of the smaller group's findings and encourage cautious interpretation due to the reduced sample size. It is conceivable that the outcomes may vary when using larger datasets from multiple centers. Our study was carried out in Bucharest, the capital of Romania, a city that has always been among the

first in terms of infection rate and the data could reflect the impact that COVID-19 had within this city and our institution and may not be consistent with other regions. Despite these limitations, we anticipate that our findings provide valuable insights into the potential impact of the pandemic on urolithiasis management. Therefore, future healthcare system reorganizations can benefit from our findings, enhancing patient safety and lowering healthcare costs.

While our findings align with similar studies conducted in other regions, our study offers valuable insights into the unique impact of the COVID-19 pandemic on ureteral lithiasis management specifically within the Romanian healthcare context. This research fills a gap in the literature by providing region-specific data and highlighting the need for adaptable healthcare strategies during public health crises in resource-limited settings.

Conclusion

Our study highlights a significant reduction in hospitalizations for ureteral lithiasis during the COVID-19 pandemic, accompanied by changes in presentation severity and treatment approach. Elevated serum creatinine levels at admission may reflect delays in seeking care. These findings suggest that reduced access to urological services – likely influenced by healthcare system restructuring during the pandemic – contributed to altered clinical management. Additionally, there was a notable shift in treatment strategies, with increased reliance on upper urinary tract drainage procedures instead of definitive stone removal.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the Local Ethics Committee of the “Saint John” Emergency Clinical Hospital, Bucharest (9420/19.04.2022). The informed consent was obtained from all participants and/or their legal guardians as applicable.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

Publication of this paper was supported by the University of Medicine and Pharmacy Carol Davila, through the institutional program Publish not Perish.

Disclosure

The authors declare no conflicts of interest in this work.

References

1. Wang C, Pan R, Wan X, et al. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health*. 2020;17(5):1729. PMID: 32155789; PMCID: PMC7084952. doi:10.3390/ijerph17051729
2. Lauxmann MA, Santucci NE, Autrán-Gómez AM. The SARS-CoV-2 coronavirus and the COVID-19 outbreak. *Int Braz J Urol*. 2020;46(suppl.1):6–18. PMID: 32549071; PMCID: PMC7719995. doi:10.1590/S1677-5538.IBJU.2020.S101
3. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. *Acta Biomed*. 2020;91(1):157–160. PMID: 32191675; PMCID: PMC7569573. doi:10.23750/abm.v91i1.9397
4. Korkes F, Smaidi K, Salles MP, Neto LAC, Heilberg IP, Glina S. COVID-19: the impact on urolithiasis treatment in Brazil. *Int Braz J Urol*. 2022;48(1):101–109. PMID: 34735086; PMCID: PMC8691230. doi:10.1590/S1677-5538.IBJU.2021.0405
5. Streinu-Cercel A, Apostolescu C, Săndulescu O, et al. SARS-CoV-2 in Romania - analysis of the first confirmed case and evolution of the pandemic in Romania in the first three months. *Germes*. 2020;10(2):132–134. PMID: 32656114; PMCID: PMC7330521. doi:10.18683/germes.2020.1198
6. Kumpunen S, Webb E, Permanand G, et al. Transformations in the landscape of primary health care during COVID-19: themes from the European region. *Health Policy*. 2022;126(5):391–397. Epub 2021 Aug 14. PMID: 34489126; PMCID: PMC8364142. doi:10.1016/j.healthpol.2021.08.002

7. "Covid: romania's health system torn apart by pandemic." BBC News. Available from: <https://www.bbc.com/news/world-europe-58992090>. Accessed April 19, 2025.
8. Gavi F, Fiori B, Gandi C, et al. Prevalence and antimicrobial resistance patterns of hospital acquired infections through the COVID-19 pandemic: real-word data from a tertiary urological centre. *J Clin Med*. 2023;12(23):7278. PMID: 38068329; PMCID: PMC10707426. doi:10.3390/jcm12237278
9. Sorokin I, Mamoulakis C, Miyazawa K, Rodgers A, Talati J, Lotan Y. Epidemiology of stone disease across the world. *World J Urol*. 2017;35(9):1301–1320. Epub 2017 Feb 17. PMID: 28213860. doi:10.1007/s00345-017-2008-6
10. Alelign T, Petros B. Kidney stone disease: an update on current concepts. *Adv Urol*. 2018;2018:3068365. PMID: 29515627; PMCID: PMC5817324. doi:10.1155/2018/3068365
11. Osther PJS Epidemiology of Kidney Stones in the European Union. In: Talati J, Tiselius H, Albala D YE Z, editors. Urolithiasis. London: Springer; 2012. doi:10.1007/978-1-4471-4387-1_1
12. Ramello A, Vitale C, Marangella M. Epidemiology of nephrolithiasis. *J Nephrol*. 2000;13(Suppl 3):S45–50. PMID: 11132032.
13. Moe OW. Kidney stones: pathophysiology and medical management. *Lancet*. 2006;367(9507):333–344. PMID: 16443041. doi:10.1016/S0140-6736(06)68071-9
14. Romero V, Akpınar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. *Rev Urol*. 2010;12(2–3):e86–96. PMID: 20811557; PMCID: PMC2931286.
15. Edvardsson VO, Indridason OS, Haraldsson G, Kjartansson O, Pálsson R. Temporal trends in the incidence of kidney stone disease. *Kidney Int*. 2013;83(1):146–152. PMID: 22992468. doi:10.1038/ki.2012.320
16. Li J, Zhao Y, Xiong Z, Yang GG. Regional, and national incidence and disability-adjusted life-years for urolithiasis in 195 countries and territories, 1990–2019: results from the global burden of disease study 2019. *J Clin Med*. 2023;12(3):1048. doi:10.3390/jcm12031048
17. Singh KB, Sailo S. Understanding epidemiology and etiologic factors of urolithiasis: an overview. *Scientific Visualization*. 2013;13(4):169–174.
18. Sofia NH, Walter TM. Prevalence and risk factors of kidney stone. *Global J Res Anal*. 2016;5(3):183–7.
19. Pogorelić Z, Milanović K, Veršić AB, et al. Is there an increased incidence of orchietomy in pediatric patients with acute testicular torsion during COVID-19 pandemic? - A retrospective multicenter study. *J Pediatr Urol*. 2021;17(4):479.e1–479.e6. Epub 2021 May 1. PMID: 33994321; PMCID: PMC8087574. doi:10.1016/j.jpuro.2021.04.017
20. Artiles Medina A, Laso García I, Mata Alcaraz M, et al. Lecciones aprendidas sobre el manejo de la urolitiasis tras los perjuicios causados por la COVID-19: un ejemplo de adaptación en un centro de alto volumen [Lessons learned after the disruption caused by COVID-19 in the management of urolithiasis: an example of adaptation in a high-volume center. *Actas Urol Esp*. 2023;47(3):149–158. Epub 2022 Jun 17. PMID: 35756714; PMCID: PMC9212612. doi:10.1016/j.acuro.2022.02.003
21. Shah TT, Gao C, Peters M, et al.; British Urology Researchers in Surgical Training (BURST) Collaborative MIMIC Study Group. Factors associated with spontaneous stone passage in a contemporary cohort of patients presenting with acute ureteric colic: results from the multi-centre cohort study evaluating the role of inflammatory markers in patients presenting with acute ureteric colic (MIMIC) study. *BJU Int*. 2019;124(3):504–513. Epub 2019 May 14. PMID: 31001912. doi:10.1111/bju.14777
22. Ribal MJ, Cornford P, Briganti A, et al. EAU section offices and the EAU guidelines panels. European Association of Urology Guidelines Office Rapid Reaction Group 2019 era. *Eur Urol*. 2020;78(1):21–28. Epub 2020 Apr 27. PMID: 32376137; PMCID: PMC7183974. doi:10.1016/j.eururo.2020.04.056
23. Stensland KD, Morgan TM, Moinezhadeh A, et al. Considerations in the triage of urologic surgeries during the COVID-19 pandemic. *Eur Urol*. 2020;77(6):663–666. Epub 2020 Apr 9. PMID: 32279903; PMCID: PMC7146681. doi:10.1016/j.eururo.2020.03.027
24. Antonucci M, Recupero SM, Marzio V, et al. The impact of COVID-19 outbreak on urolithiasis emergency department admissions, hospitalizations and clinical management in central Italy: a multicentric analysis. *Actas Urol Esp*. 2020;44(9):611–616. Epub 2020 Jul 3. PMID: 32713658; PMCID: PMC7332912. doi:10.1016/j.acuro.2020.06.005
25. Gul M, Kaynar M, Yıldız M, et al. The increased risk of complicated ureteral stones in the era of COVID-19 pandemic. *J Endourol*. 2020;34(8):882–886. Epub 2020 Jul 29. PMID: 32668987. doi:10.1089/end.2020.0658
26. Fakhr Yasseri A, Aghamir SMK. Urinary stone management during the COVID-19 pandemic: a suggested approach and review of literature. *Ther Adv Urol*. 2020;12:1756287220939513. PMID: 32849913; PMCID: PMC7425260. doi:10.1177/1756287220939513
27. Proietti S, Gaboardi F, Giusti G. Endourological stone management in the era of the COVID-19. *Eur Urol*. 2020;78(2):131–133. Epub 2020 Apr 14. PMID: 32303384; PMCID: PMC7195508. doi:10.1016/j.eururo.2020.03.042
28. Byrne MHV, Georgiades F, Light A, et al. COVID stones collaborative. Impact of COVID-19 on the management and outcomes of ureteric stones in the UK: a multicentre retrospective study. *BJU Int*. 2023;131(1):82–89. Epub 2022 Oct 19. PMID: 36083711; PMCID: PMC9539039. doi:10.1111/bju.15882
29. Carrion DM, Mantica G, Antón-Juanilla MM, et al. Assessment of trends and clinical presentation in the emergency department of patients with renal colic during the COVID-19 pandemic era. *Actas Urol Esp*. 2020;44(10):653–658. Epub 2020 Sep 7. PMID: 32993921; PMCID: PMC7476606. doi:10.1016/j.acuro.2020.08.006
30. Kaczmarek K, Kalemekiewicz J, Jankowska M, et al. Did the COVID-19 pandemic restrict access to emergency urological services: assessment of reorganisation effectiveness for hospital treatment. *Int J Environ Res Public Health*. 2023;20(4):3735. PMID: 36834430; PMCID: PMC9965512. doi:10.3390/ijerph20043735
31. Thapa BB, Shrestha D, Bista S, Thapa S, Niranjana V. Urology during COVID-19 pandemic crisis: a systematic review. *Surg J*. 2021;7(1):e3–e10. PMID: 33469564; PMCID: PMC7810570. doi:10.1055/s-0040-1722341
32. Motterle G, Morlacco A, Iafraite M, et al. The impact of COVID-19 pandemic on urological emergencies: a single-center experience. *World J Urol*. 2021;39(6):1985–1989. Epub 2020 May 23. PMID: 32447443; PMCID: PMC7245166. doi:10.1007/s00345-020-03264-2
33. Mazzon G, Ferretti S, Serafin E, et al. COVID-19 outbreak impact on urolithiasis treatments: a multicenter retrospective study across 9 urological centers in Italy. *Curr Urol*. 2024;18(4):301–306. doi:10.1097/CU9.0000000000000246
34. Spooner J, Masoumi-Ravandi K, MacNevin W, Ilie G, Skinner T, Lantz Powers A. Septic and febrile kidney stone presentations during the COVID-19 pandemic: what is the effect of reduced access to care during pandemic restrictions? *Can Urol Assoc J*. 2023;18(1):E19–25. doi:10.5489/cuaj.8450

35. Mojoli F, Cutti S, Mongodi S, et al. The potential role of ICU capacity strain in COVID-19 mortality: comparison between first and second waves in Pavia, Italy. *J Anesth Analg Crit Care*. 2021;1(1):8. doi:10.1186/s44158-021-00007-6
36. Gao Y, Sun F, Jiang W, et al. Beliefs towards the COVID-19 pandemic among patients with emotional disorders in China. *Gen Psychiatr*. 2020;33(3):e100231. PMID: 32574346; PMCID: PMC7287490. doi:10.1136/gpsych-2020-100231
37. Flammia S, Saliccia S, Tufano A, Busetto GM, Ricciuti GP, Sciarra A. How urinary stone emergencies changed in the time of COVID-19? *Urolithiasis*. 2020;48(5):467–469. Epub 2020 May 28. PMID: 32468127; PMCID: PMC7255446. doi:10.1007/s00240-020-01198-3
38. Anderson S, McNicholas D, Murphy C, et al. The impact of COVID-19 on acute urinary stone presentations: a single-centre experience. *Ir J Med Sci*. 2022;191(1):45–49. Epub 2021 Feb 25. PMID: 33629270; PMCID: PMC7904391. doi:10.1007/s11845-021-02562-x
39. Nourian A, Uppaluri C, Chen M, Ghiraldi EM, Friedlander JI. Comparison of management and outcomes of symptomatic urolithiasis during the COVID-19 pandemic to a comparative cohort. *Urology*. 2022;165:178–183. Epub 2022 Jan 26. PMID: 35090864; PMCID: PMC8789389. doi:10.1016/j.urology.2022.01.019
40. Porreca A, Colicchia M, D'Agostino DA, et al. Urology practice during the COVID-19 vaccination campaign. *Urol J*. 2021;88(4):237–241. doi:10.1177/03915603211016321
41. Carr EJ, Wu M, Harvey R, et al. Systematic review of safety and efficacy of COVID-19 vaccines in patients with kidney disease. *Kidney Int Rep*. 2021;6(5):1407–1415. doi:10.1016/j.ekir.2021.03.005

Research and Reports in Urology

Publish your work in this journal

Research and Reports in Urology is an international, peer-reviewed, open access journal publishing original research, reports, editorials, reviews and commentaries on all aspects of adult and pediatric urology in the clinic and laboratory including the following topics: Pathology, pathophysiology of urological disease; Investigation and treatment of urological disease; Pharmacology of drugs used for the treatment of urological disease. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/research-and-reports-in-urology-journal>

Dovepress
Taylor & Francis Group