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COVID-19 outbreak impact on urolithiasis treatments: A multicenter retrospective study across 9 urological centers in Italy

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Abstract

Background: The coronavirus disease (COVID-19) pandemic has posed challenges to the global health care community, affecting the management of upper urinary tract stones.

Materials and methods: This retrospective study involved 9 Italian centers. We compared the 12-month period prior to COVID-19 (March 1, 2019, to February 28, 2020; Period A) with the COVID-19 period (March 1, 2020, to February 28, 2021, Period B). This study aimed to compare outcomes during Periods A and B, specifically focusing on the overall number of treatments, rate of urgent/elective cases, and operational complexity.

Results: A total of 4018 procedures were collected, comprising 2176 procedures during Period A and 1842 during Period B, indicating a loss of 15.35% ($p < 0.001$). In the elective cases, 1622 procedures were conducted in Period A, compared with 1280 in Period B, representing a 21.09% reduction in cases ($p = 0.001$). All types of stone treatments were affected: extracorporeal shock wave lithotripsy (–29.37%, $p = 0.001$), percutaneous nephrolithotomy (–26.47%, $p = 0.008$), retrograde surgeries for renal stones (–10.63%, $p = 0.008$), and semirigid ureterolithotripsy (–24.86%, $p = 0.008$). Waiting lists experienced significant delays during Period B. The waiting time (WT) for elective procedures increased during Period B ($p < 0.001$). For ureteral stones, the mean WT in Period A was 61.44 days compared with 86.56 days in Period B ($p = 0.008$). The WT for renal stones increased from 64.96 days in Period A to 85.66 days in Period B for retrograde intrarenal surgery ($p = 0.008$) and from 96.9 days to 1103.9 days ($p = 0.035$) for percutaneous nephrolithotomy procedures.

Conclusions: Our study demonstrates that COVID-19 significantly disrupted endourological services across the country. Our data underline how patients received treatment over a prolonged period, potentially increasing the risk of stone-related complications and patient discomfort.

Keywords: COVID-19; Urolithiasis; Percutaneous nephrolithotomy; Retrograde intrarenal surgery; Extracorporeal shock wave lithotripsy

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1. Introduction

In December 2019, a novel coronavirus was noticed by World Health Organization.[1] This novel entity was termed severe acute respiratory syndrome–related coronavirus 2 (SARS-CoV-2), and the resulting illness was labeled coronavirus disease (COVID-19). The rapid spread of SARS-CoV-2 led the World Health Organization to declare it a pandemic on March 11, 2020.[2] In Italy, the initial documented case of person-to-person transmission occurred on February 21, 2020.[3] As of August 8, 2022, Italy has reported 21,325,402 total cases and 173,249 deaths,[4] whereas globally, >574 million confirmed cases and >6.3 million deaths have been registered as of July 31, 2022.[5] The exponential surge in COVID-19 cases has overwhelmed health care systems worldwide. Italy, during critical phases, postponed nonurgent operations and revised the management of emergency cases to minimize routine hospitalization, ensuring resources were available for SARS-CoV-2 patient care.[6,7] This restructuring significantly impacted urological practice, necessitating a comprehensive reorganization of departmental activities. It also mandated clear determinations regarding deferable procedures. Urolithiasis could lead to severe complications if not treated in a timely manner, including infectious events, renal function deterioration, and kidney loss. Furthermore, patients with prolonged painful conditions (attributed to obstructed renal units or indwelling stents) may require multiple accesses to emergency departments or urology outpatient clinics, thereby increasing the workload of services already under pressure.[8] Therefore, several attempts have been made to develop guidelines to support urologists in this regard.[8,9]

In this study, we aimed to analyze the impact of the COVID-19 pandemic on both elective and emergency urological procedures for urinary stones by assessing the variations in surgical volumes and perioperative characteristics of patients before and after the COVID-19 outbreak.

2. Materials and methods

We conducted a retrospective observational study involving 9 high-volume Italian urological centers that regularly deliver treatments for urinary stones. The study included 6 academic hospitals (Trieste, Verona, Naples, Modena, Milan, and Turin), 2 high-volume public tertiary referral centers (Parma and Bassano del Grappa), and 1 publicly funded private hospital delivering both elective and emergency services to the local community (Brescia). All these departments suffered significant disruptions during the pandemic due to government limitations, were heavily affected by the initial COVID-19 outbreak, and have been involved in the pandemic management since the beginning of the national outbreak. In this study, patients who underwent any procedure for upper urinary tract stones, either electively or in an emergency setting, were included. Monitored surgeries were any of the following: ureteric stent insertion, percutaneous nephrostomy insertion, semirigid ureterolithotripsy (URS), retrograde intrarenal surgery (RIRS), extracorporeal shock wave lithotripsy (ESWL), mini–percutaneous nephrolithotomy (mini-PCNL), standard PCNL, pyelolithotomy, and nephrectomy. The most appropriate treatment was decided by surgeons following guidelines and according to the characteristics of the stone, the choice of the patients, available equipment/operating rooms, and the expertise of the specialist.

Patients treated during the 12-month period before COVID-19 (from March 1, 2019, to February 28, 2020, named Period A) were compared with those treated during the COVID-19 period (from March 1, 2020, to February 28, 2021, named Period B). The duration of these periods was determined by the conclusion of government limitations, which ended in March to April 2021. The cases involved both elective and emergency scenarios (patients admitted to the hospital due to urgent conditions).

Preoperative descriptive variables included age (years), sex (male/female), stone location (renal, ureteric, and both renal and ureteric), and the age-adjusted Charlson Comorbidity Index (CCI). Treatments were compared in terms of the stone-free rate (SFR), defined as absence of persisting fragments ≥2 mm in maximum diameter; waiting time (WT), defined as the time passed from booking to treatment, expressed in days; cumulative stone diameter, expressed in mm; percentage of patients treated after previous ureteric stent insertion/nephrostomy tube insertion; operations conducted in the presence of an encrusted ureteric stent; and complication rates. Cumulative perioperative data subdivided by procedure type in Periods A and B were compared.

The inclusion criteria included age >18 years at the time of surgery and completion of ≤3 months of follow-up. The exclusion criteria comprised procedures performed for bladder/urethral stones, age <18 years, and pregnancy. To evaluate stone complexity, we used Guy's[10] and STONE nephrolithometry scoring systems.[11] Comorbidities were described using CCI. Thirty days postoperative complications were recorded and reported using the Clavien-Dindo classification system. In case of PCNL, a modified version of that described by de la Rosette et al.[12] was used. During preoperative assessment and follow-up, ultrasonography, computed tomography, and plain radiography were accepted as imaging modalities according to surgeon decision. The WT and Clavien-Dindo classification system were calculated only for elective procedures. This study was conducted after obtaining ethical approval from each center. Ethical approval from the main investigation site (Bassano) was coded as VI-183, dated February 17, 2021. This study was conducted in accordance with the Declaration of Helsinki (revised in 2013).

2.1. Statistical analysis

All data were analyzed using IBM Statistical Package for the Social Sciences Statistics version 25.0 (IBM SPSS Statistics, Armonk, NY, USA). Continuous variables were presented as means and SD in cases of normal distribution and compared using the independent Student *t* test, whereas skewed distributions were presented as median and interquartile range and compared using the Mann-Whitney *U* test. Categorical variables are presented as numbers with percentages and were compared using the χ^2 or Fisher exact tests. Correlations between continuous variables were assessed using the Pearson and Spearman rank correlation coefficients. Statistical significance was considered at 2-tailed $p < 0.05$.

3. Results

A total of 4018 patients were enrolled in the study, and 83 patients were excluded. Of these, 65 were pregnant, and 18 were children. Overall, 2176 patients were treated during Period A, whereas 1842 procedures were performed during Period B, corresponding to a loss of 15.35% of cases ($p < 0.001$). Overall, the number of elective procedures dropped from 1622 cases in Period A to 1280 cases in Period B, corresponding to a loss of 21.09% ($p < 0.001$). Majority of interventions were affected, particularly ESWL (487–344 cases [−29.37%]; $p = 0.001$), URS (547–411 cases [−24.86%]; $p = 0.008$), RIRS (433–387 cases [−10.63%]; $p = 0.008$), and standard PCNL (97–59 cases [−39.59%]; $p = 0.008$). Emergency procedures demonstrated a slight increase during Period B, from 554 cases during Period A to 562 cases in the latter period (+1.4%; $p = 0.035$). The results are summarized in Table 1. During Period B, none of the elective procedures were performed in patients with ongoing COVID-19. Among the emergency cases, 16 procedures (2.84%) were conducted in patients with COVID-19, including 11 (2.66%) ureteric stents and 5 (6.66%) percutaneous nephrostomy placements.

In Table 2, we reported WTs for elective procedures during Periods A and B. Overall, vast majority of surgeries revealed a statistically significantly longer WT; longer WT was noticed for percutaneous nephrostomy insertion (+34.80 days; $p = 0.008$), URS (+25.12 days; $p = 0.008$), and RIRS (+20.72 days; $p = 0.008$).

Table 1

Variations in surgical volumes of elective and emergency procedures during Periods A and B.

Type of surgery	Period B no. of patients	Period A no. of patients	Volume gap (%)	p
Elective cases				
ESWL	344	487	−143 (−29.37)	0.001[a]
Ureteric stenting	43	40	+3 (+7.50)	0.142[a]
Percutaneous nephrostomy	10	2	+8 (+500)	0.001[a]
URS	411	547	−136 (−24.86)	0.008[a]
RIRS	387	433	−46 (−10.63)	0.008[a]
Mini-PCNL	66	73	−7 (−8.34)	0.008[a]
Standard PCNL	59	97	−38 (−39.59)	0.008[a]
Pyelolithotomy[†]	6	0	+6 (+600)	0.001[a]
Nephrectomy	1	2	−1 (−50)	0.354[a]
Total	1280	1622	−342 (−21.09)	<0.001[a]
Emergency cases				
Ureteric stenting	412	406	+6 (+1.46)	0.062[a]
Percutaneous nephrostomy	75	80	−5 (−6.6)	0.086[a]
URS	73	67	+6 (+8.90)	0.031[a]
Nephrectomy	2	1	+1 (+50)	0.245[a]
Total	562	554	+8 (+1.4)	0.035[a]

[a]Pearson χ^2 test.
ANOVA = analysis of variance; ESWL = extracorporeal shock wave lithotripsy; PCNL = percutaneous nephrolithotomy; Period A = pre–COVID-19; Period B = COVID-19; RIRS = retrograde intrarenal surgery; URS = semirigid ureterolithotripsy.

Mini-PCNL revealed the opposite trend, with the WT reduced by 10.12 days ($p = 0.009$).

Table 3 shows the perioperative characteristics of treated patients. We did not observe any differences in the SFR for any of the analyzed procedures. The stone burden and complication rates were also comparable between the periods ($p = 0.089$).

However, during Period B, a significantly increased number of patients were treated with preliminary ureteric stenting. Specifically, the proportion of presented patients undergoing URS increased from 18.3% in Period A to 27.6% in Period B ($p = 0.037$). The number of RIRS cases increased from 20.5% to 32.6% ($p = 0.027$). The same effect was observed in standard PCNL, with the proportion of presented patients increasing from 7.1% to 18.9% ($p = 0.008$). Patients who underwent indwelling percutaneous nephrostomy showed different trends. In fact, during Period B, only those who underwent URS had an increased percentage of preliminary percutaneous drainage placements (6.2% in Period A to 8.5% in Period A; $p = 0.046$), whereas the other procedures showed the opposite trend. Interestingly, during Period B, we did not notice an increased number of patients treated for an encrusted stent.

In Supplementary Tables 1–5 (http://links.lww.com/CURRUROL/A54), we report the detailed perioperative data on ESWL, URS, RIRS, mini-PCNL, and standard PCNL, respectively. In addition to the differences in surgical volumes and WTs, some differences in patient characteristics have emerged. In fact, the data showed an increased utilization of ESWL for the treatment of ureteric stones during Period B (from 24.4% to 41.6%; $p = 0.021$).

Table 2

Mean waiting time (from booking to treatment) for elective procedures delivered pre- and post–COVID-19 outbreak.

Type of surgery	Period B mean days (SD)	Period A mean days (SD)	Days gap	p
ESWL	45.08 (48.88)	36.13 (21.38)	+8.95	0.001[a]
Ureteric stenting	53.48 (65.55)	38.18 (43.47)	+15.3	0.024[a]
Percutaneous nephrostomy	37.80 (37.50)	3 (2.83)	+34.80	0.008[a]
URS	86.56 (71.63)	61.44 (59.45)	+25.12	0.008[a]
RIRS	85.66 (66.01)	64.96 (54.53)	+20.72	0.008[a]
Mini-PCNL	69.02 (53.80)	79.14 (75.39)	−10.12	0.009[a]
Standard PCNL	103.98 (82.38)	96.96 (54.53)	+7.02	0.035[a]
Pyelolithotomy	68.33 (76.18)	N/A	N/A	N/A[a]
Nephrectomy	24.0 (N/A)	166 (N/A)	−142	0.392[a]
Total	74.00 (66.89)	57.22 (54.12)	+16.78	0.008[a]

[a]Pearson χ^2 test.
ESWL = extracorporeal shock wave lithotripsy; N/A = not applicable; PCNL = percutaneous nephrolithotomy; Period A = pre–COVID-19; Period B = COVID-19; RIRS = retrograde intrarenal surgery; URS = semirigid ureterolithotripsy.

Table 3

Postoperative parameters.

Type of surgery	Period B	Period A	p
Stone-free rate, %			
ESWL	63.4	67.3	0.512[a]
URS	79.6	82.9	0.220[a]
RIRS	72.9	71.7	0.719[a]
Mini-PCNL	61.1	69.2	0.408[a]
Standard PCNL	58.5	56.4	0.798[a]
Pyelolithotomy	66.6	N/A	N/A[a]
Cumulative stone diameter (SD), mm			
ESWL	9.32 (4.21)	8.32 (3.67)	0.076[a]
URS	9.96 (3.85)	9.30 (4.04)	0.334[a]
RIRS	11.24 (4.32)	11.87 (5.36)	0.087[a]
Mini-PCNL	19.87 (7.85)	24.04 (9.95)	0.046[a]
Standard PCNL	24.35 (11.29)	26.38 (11.65)	0.296[a]
Pyelolithotomy	38.42 (7.21)	N/A	N/A[a]
No. of patients treated with indwelled ureteric stent (%)			
ESWL	30 (9.1)	32 (6.8)	0.061[a]
URS	198 (27.6)	94 (18.3)	0.037[a]
RIRS	121 (32.6)	86 (20.5)	0.027[a]
Mini-PCNL	5 (6.2)	4 (5.2)	0.182[a]
Standard PCNL	11 (18.9)	7 (7.1)	0.008[a]
Pyelolithotomy	0	N/A	N/A[a]
No. of patients treated with indwelled percutaneous nephrostomy (%)			
ESWL	3 (0.8)	2 (0.4)	0.381[a]
URS	41 (8.5)	38 (6.2)	0.046[a]
RIRS	15 (3.8)	19 (4.4)	0.183[a]
Mini-PCNL	3 (4.5)	5 (6.8)	0.092[a]
Standard PCNL	4 (6.8)	7 (7.2)	0.071[a]
Pyelolithotomy	0	N/A	N/A[a]
No. of procedures carried out for encrusted stent (%)			
ESWL	0	0	N/A[a]
URS	41 (8.5)	42 (6.9)	0.328[a]
RIRS	24 (6.3)	22 (5.4)	0.604[a]
Mini-PCNL	1 (1.6)	2 (2.9)	0.642[a]
Standard PCNL	4 (6.8)	4 (4.2)	0.475[a]
Pyelolithotomy	0	0	N/A[a]
Clavien-Dindo grade, no. of patients (%)			0.089[a]
1	163 (5.6)	109 (6.7)	
2	133 (4.6)	82 (5.1)	
3a	23 (0.8)	16 (1.0)	
3b	20 (0.7)	11 (0.7)	
4a	22 (0.8)	15 (0.9)	
Missing	281	301	

[a]Pearson χ^2 test.
ANOVA = analysis of variance; ESWL = extracorporeal shock wave lithotripsy; N/A = not applicable; PCNL = percutaneous nephrolithotomy; Period A = pre–COVID-19; Period B = COVID-19; RIRS = retrograde intrarenal surgery; URS = semirigid ureterolithotripsy.

Furthermore, during Period B, a larger number of RIRS procedures were performed for ureteric stones: 75 (23.7%) versus 55 (13.4%) in Period A ($p < 0.001$).

Considering only percutaneous surgeries, the surgical complexity did not seem to differ between the 2 periods. In fact, stone volumes resulted in similar mean cumulative stone diameter of 24.04 and 19.87 during Periods A and B, respectively, for mini-PCNLs ($p = 0.046$); and 26.38 and 24.35 for standard PCNLs ($p = 0.296$). Analyzing the STONE score, a slight difference emerged only for standard PCNLs, with an increase from 7.63 to 8.21 ($p = 0.044$; Supplementary Table 5 [http://links.lww.com/CURRUROL/A54]). Furthermore, by analyzing the CCI results, patient comorbidities did not seem to differ between periods or for each procedure.

4. Discussion

Our study analyzed the impact of COVID-19 on Italian urological surgical activity, documenting a 15.35% reduction in all procedures ($p < 0.001$) after the onset of the COVID-19 pandemic. Considering elective procedures only, the percentage loss was even larger, increasing to 21.09% of the procedures in the pre-COVID period ($p = 0.001$). The COVID-19 pandemic is a major challenge for health care systems worldwide.[13] Since the first reported case in Italy, the exponential growth of COVID-19 cases has rapidly overwhelmed Italian health care systems, resulting in the partial or total suspension of elective activities to reduce the number of patients requiring hospitalization and free up personnel and equipment for SARS-CoV-2 patient care.[6,7]

During the initial phase of the outbreak, urological procedures dropped by 78%[14]; consequently, urological surgical waiting lists lengthened, with possible repercussions on the health of the patients.[15]

Urolithiasis can lead to severe complications and increase the burden on emergency services if not treated promptly, with 15% of these patients requiring intensive care unit admission despite decompression of the urinary system and antibiotic therapy, and a mortality rate as high as 8% to 10%.[16] Whereas obstructive or infected urolithiasis should be treated promptly, the management of nonobstructive renal stones can be safely postponed. Nevertheless, delayed intervention may decrease patient quality of life and increase their distress due to prolonged stent-related irritative symptoms and pain, difficult management of percutaneous nephrostomy, anxiety, and stone growth requiring a more complex or invasive procedure at a later stage. Patients with symptomatic urolithiasis and those with preexisting stents should be considered priorities,[8] even though most ureteric stents can remain in place for up to 6 to 12 months, according to a consensus.[9] Incorrect management of urolithiasis can have a significant impact on patient safety. Evaluating the cause of 1034 deaths in patients with proven urological conditions, Galiabovitch et al.[17] reported 9.7% of them were related to upper urinary tract stones. Furthermore, urinary sepsis was the primary cause of death after endourological intervention (49.5%). The same authors revealed that 39% of postoperative deaths were associated with inappropriate clinical management, notably delays in diagnosis and treatment. Concerning the COVID-19 period, various studies have presented conflicting data. Some authors have noted an increase in complex cases, alongside a rise in patients experiencing acute kidney injury and urinary tract infections,[18,19] whereas others have not observed such changes,[20,21] aligning with our study.

In this context, the appropriate approach to managing patients with urolithiasis remains crucial.

Naspro and Da Pozzo[22] similarly reported a 30% reduction in urological surgical volume within 15 days of outbreak onset. Analogous effects were also noted by Raheem et al.[23] in Saudi Arabia and by Yildiz et al.[24] in Turkey. Overall, a 34% decrease in all elective procedures was observed by the authors, whereas emergency cases were reduced by 9.3%, as reported by Porreca et al.[25]

Similar trends have been observed in other urological fields in Italy. Oderda et al.[26] reported a consistent reduction in elective activity concerning uro-oncological surgery. Moreover, other Italian surgical specialties were negatively affected by the pandemic. Studies, such as Pignatti et al.[27] in plastic surgery, reported a decrease in elective surgeries. Martellucci et al.[28] documented implications for emergency surgical activities, reporting a significant reduction in emergencies for acute appendicitis or complicated hernias.

The reduction in all surgical procedures for urolithiasis during COVID-19, as compared with other periods, was reported by 2 articles[20,29] but not by Artiles Medina et al.[18] from their hospital in Madrid, Spain. Interestingly, the authors noted a higher rate of complications during the pandemic period.[18] In the remaining 2 studies, one conducted in China, the authors found a reduction in all surgical procedures: ESWL (−17.9%), URS (−51.9%), RIRS (−21.9%), mini-PCNL (−60.8%), and standard PNL (−95.2%).[20] Another study analyzing hospital admissions and surgical procedures related to stone diagnosis (*International Classification of Diseases, 10th Revision* N20) in Brazil between March 2017 and February 2021 found a significant reduction in the COVID-19 period compared with the period of 2017–2019, despite a trend of increasing procedure numbers in recent years. Unfortunately, the authors did not report the clinical data regarding these procedures, such as SFR, complications, or WTs.[29]

In our study population, we observed a significant increase in WTs. Specifically, for elective procedures during Period B, the mean wait time increased to 74 (66.89) days compared with 57.22 (54.12) days ($p < 0.001$, Table 2). The WTs for standard- and mini-PCNLs exhibited distinct trends. Standard PCNLs experienced a 7.02-day increase in wait time ($p = 0.035$), whereas mini-PCNLs indicated a reduction of 10.12 days ($p = 0.009$). A similar lengthening of WTs was reported by García-Rojo et al.[15] Regarding mean WTs during the COVID-19 period: for URS, it was 94.12 versus 75.0 days ($p = 0.003$); PNCL, 87.71 versus 72.0 days ($p = 0.4$); and RIRS, 92.75 versus 91.70 days ($p = 0.66$).

Furthermore, Artiles Medina et al.[18] reported an increased WT for surgery from 46.5 (SD, 34.6) days in 2019 to 72.0 (SD, 84.6) days in the same period in 2020, without specifying the WT for the different procedures.

The data presented in this study were collected from 9 urological centers. Several factors could have variably affected patient care, including the logistics and internal organization of each center, the number of hospitalized patients with COVID-19, and national/local regulations for outbreak management. These differences likely contributed to the heterogeneous capacity of centers to provide prompt urological care.

For instance, certain centers had dedicated COVID-19–free units operational during the outbreak. This facilitated the more efficient delivery of surgeries, evident in the reduction of mini-PCNL wait times (−10.2 days) during the COVID-19 period. In addition, centers with in-house outpatient ESWL services expanded their indications for ESWL due to the lack of operating sessions. Notably, during Period B, a significant increase was observed in the proportion of patients with ureteric stones, rising from 24.4% in Period A to 41.6% in Period B ($p = 0.021$; Supplementary Table 1, http://links.lww.com/CURRUROL/A54).

Overall, the study found no discernible differences in the quality of surgeries between the 2 periods indicated by similar rates of SFRs and complications. Notably, during Period B, a significantly higher number of patients received treatment after previous ureteric stent insertion (Table 3), with variable increases ranging from 1% and 12% across different types of surgeries. These findings have significant implications for future research. The preliminary drainage of the renal unit has been considered crucial, especially during expected prolonged WTs, aiming to prevent complications stemming from renal obstruction and minimize unnecessary operations, particularly during the initial pandemic phase. Furthermore, the use of ureteric stents might lead to reduced patient quality of life, raising concerns about their unnecessary use. Regarding the utilization of percutaneous nephrostomies, a significant difference was observed solely for URS (6.2% in Period A to 8.5% in Period B), whereas slight reductions were observed in other cases, although not statistically significant. From the data analysis, we did not observe potential effects of prolonged renal obstruction stemming from stones. The number of nephrectomies due to obstructing stones remained consistent between the 2 periods, with 3 reported during Period A and 3 during Period B (Table 1). In our opinion, accurately understanding the impact of prolonged renal obstruction and treatment delays necessitates longer monitoring; therefore, further studies are necessary.

This study investigated the effect of COVID-19 on all procedures for urinary stones performed during emergencies and elections in 9 high-volume centers located in different areas of Italy. It demonstrated the contraction of surgical volumes, specifically for elective procedures, and a prolongation of the WTs. A certain number of differences in surgical indications also emerged, but the overall treatments maintained similar quality, as shown by the analysis of SFR and complication rates. In addition, we did not observe any major differences in the characteristics of the treated patients.

Limitations

However, this study had some limitations that need to be acknowledged. First, the data were collected retrospectively, which might have led to missing data. This could potentially introduce bias into the data analysis. The absence of a comparison with the post-acute pandemic period is notable, indicating a need for further studies to understand the changes in the urological field as we continue to grapple with the lasting impact of COVID-19. In addition, due to the nature of the study, the use of imaging modalities resulted in heterogeneity, potentially impacting the accuracy of estimated SFRs.

Furthermore, owing to the characteristics of the study, we could not evaluate the increase in workload in emergency departments and urological outpatient clinics caused by delayed treatment, stent-related symptoms, and infectious complications. A larger cohort of patients should be enrolled from a wider selection of urological centers to confirm this trend. During Period B, among the urgent cases performed despite patients being positive for COVID-19, we were unable to discern the number of patients with symptomatic infection. Lastly, we could not evaluate whether patients contracted COVID-19 following hospitalization for stone treatment.

Our study highlighted how COVID-19 significantly disrupted endourological services for urinary stones nationwide. A reduced number of patients received treatment over an extended period (approximately 1 in 5 patients could not receive treatment). Assessing the actual impact of these delays during the pandemic is challenging, especially concerning the increased risk of renal function loss and infectious complications, such as severe sepsis. The effect on patient's quality of life remains unclear, necessitating further studies.

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None

Statement of ethics

This study was conducted after obtaining ethical approval from each center. Ethical approval from the main investigation site (Bassano) was coded as VI-183, dated February 17, 2021. This study was conducted in accordance with the Declaration of Helsinki (revised in 2013). Informed consent was obtained from all individual participants included in the study.

Conflict of interest statement

No conflict of interest has been declared by the authors.

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Author contributions

GM, SF, MAC, AA, AC: Participated in research design;
GM, SF: Participated in the writing of the paper;
GM, SF, ES, FC, PA, DB, FG, GC, AP, AVF, DC, UM, GC, TM, FDM, AB, MC, NP, MT, AP, DC, LC, SM, CT, GM: Participated in the performance of the research;
GM, SF: Participated in data analysis.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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