

Changes in practice patterns of nephrolithiasis in the era of the coronavirus disease 2019 pandemic: a review

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Purpose of review

The coronavirus disease 2019 (COVID-19) pandemic led to a drastic change in healthcare priorities, availability of resources and accommodation of different needs and scenarios. We sought to review the effect of the pandemic on different aspects of nephrolithiasis.

Recent findings

The pandemic resulted in a significant impact on management of patients with nephrolithiasis around the world. A significant decrease in patient presentation and differences in strategies of management to truncate exposure and surgery time and expedite patient discharge deferring definitive management has been noted. Moreover, new safety measures such as COVID-19 PCR testing prior to surgery and limiting any intervention for COVID-19 positive patients to only life-saving scenarios has been implemented. Different emergency triaging proposals are being used, mainly including high risk patients with septic shock or complete obstruction/renal injury. Moreover, the emergence of telehealth has changed outpatient practice dramatically with a significant adoption to minimize exposure. Lastly, the effect of COVID-19 on renal physiology has been described with significant potential to cause morbidity from immediate or delayed acute kidney. No physiological effect on stone formation has yet been described, and transmission through urine is rare.

Summary

The COVID-19 pandemic has markedly shifted the treatment of nephrolithiasis in many ways, including emergency triage, outpatient care, and definitive management. Although various approaches and algorithms proposed are meant to optimize management in the time of the pandemic, further studies are required for validation.

Keywords

coronavirus disease 2019, nephrolithiasis, telehealth, urolithiasis

INTRODUCTION

Nephrolithiasis is a common medical and urological disease that can potentially cause significant morbidity to the patient especially if ignored. The coronavirus disease 2019 (COVID-19) pandemic overran our healthcare resources, and elective surgeries had declined significantly during the surge to cater to the high volume of patients in vital need of medical attention due to the virus. The effect of the pandemic lead to more difficulty in managing other diseases and has prompted a significant change in practice patterns including nephrolithiasis. The ideal management of nephrolithiasis consumes a significant amount of scarce healthcare resources that could be otherwise be diverted to help patients during the COVID-19 pandemic. In this review, we sought to examine the effect of the pandemic on different aspects of nephrolithiasis. Previously published nonsystematic review regarding impact of COVID-19 on nephrolithiasis management covered less than 6 months of initial pandemic period [1,2]. Present review provides more recent update on impact of COVID-19 on practice patterns of nephrolithiasis over a period of almost 2 years.

We performed a literature review on PubMed, Web of Science and Google scholar for all relevant

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KEY POINTS

- Understand the impact of coronavirus disease 2019 (COVID-19) on nephrolithiasis emergencies and how to triage.
- Understand the impact of urologic surgeries on COVID-19 positive or suspected patients.
- Promoting the safety and efficacy of telehealth and remote visits for outpatient management of nephrolithiasis.
- Role of definitive management of nephrolithiasis during the pandemic.
- Describe long-term effects of COVID-19 infections on nephrolithiasis patients.

articles in English from January 1, 2020 to December 15, 2021 with keywords including: COVID-19 and nephrolithiasis, urolithiasis, stone disease, ureteroscopy (URS), percutaneous renal surgery and lithotripsy, kidney stones, ureteric stones, and bladder stones. All the original articles, review articles and case series considered by all co-authors to be relevant regarding impact of COVID-19 on practice pattern of nephrolithiasis were included in the review. Redundant review articles and commentaries were excluded. The quality of literature was considered low or moderate as per 'GRADE certainty ratings' by all the authors for all the included articles [3]. Most of the studies were either an expert opinion or retrospective review with small sample size.

IMPACT OF PANDEMIC ON STONE RELATED EMERGENCIES

Presentation

In 2009, urolithiasis accounted for approximately 1.3 million emergency department (ED) visits in the United States. This amounted to an average of 3642 ED encounters for kidney stone disease each day. Of these, approximately 20% of patients required hospitalization [4]. However, social restrictions and lockdowns during COVID-19 surges and patients' fears of increased risk of contracting COVID-19 resulted in a significant decline in ED visits during the pandemic [6]. Experience from three high volume centers in Italy revealed a 48% reduction in ED visits and those admitted to the ED during COVID-19 had 9.5% more complications and 17.9% greater risk of hospitalization [5[•]]. Jiang *et al.* [7] analyzed 'REDDIT' social media discussion boards pre and during COVID-19 and confirmed that patients were more anxious and reluctant to visit the ED during the pandemic. It is important to note that the demographic of people using REDDIT platform may include more younger and tech savvy population and may not be representative of the demographic of most stone formers.

It was also noted that patients would prefer conservative treatment at home and reserved ER visits for larger stones, potentially causing selfharm. Echoing the risk related to patients' choices during the COVID-19 pandemic, two studies concluded that patients presenting to the ED for nephrolithiasis seemed to present with a higher serum creatinine and leukocytosis, more distal stone position in the mid to lower ureter, and an increased rate of hydronephrosis [6,8].

Management

It must be noted that one of the most important measure to take during this pandemic is that a COVID-19 PCR test should be administered within 48 h preoperatively to patients planned for surgery [13].

The pandemic resulted in a trend toward more conservative management from 38.2% to 81% of patients and simultaneous reduction in definitive treatment from 60.8% to 19% after the first 3 weeks of the pandemic [9]. When emergency stone workload and management during the 6-week COVID-19 surge from March 1 to April 15, 2020 in Italy was compared with the pre-COVID-19 era in 2019, the authors noted that more patients underwent placement of nephrostomy tubes, and none underwent URS as definitive treatment during this time frame [5[•]]. Trend in less surgery and fewer primary URS/ laser could reflect patients presenting septic/not straight forward URS. This would preclude primary URS in some cases and may overestimate the degree in change of management. Bedside nephrostomy tube placement under local anesthesia was preferred over ureteral stent insertion in order to spare ventilators [10]. Proietti et al. [11], however, preferred to avoid nephrostomy tube placement whenever possible, due to high risk of inadvertent removal and likely long delay for subsequent definitive stone removal procedure.

A survey of 60 physicians from 20 European countries revealed that 89.4% changed their approach from definitive stone management to stenting and nephrostomy drainage [12]. Contrary to these overall trends in delaying definitive treatment during pandemic, Carneiro *et al.* [13] recommended that COVID-19 negative patients needing urgent intervention for ureteric stones should undergo definitive lithotripsy whenever possible and well tolerated, with postoperative placement

of stent on string, instead of only drainage. They asserted that this strategy would not only lead to definitive treatment but would likely reduce the number of visits to hospital during the pandemic.

UROLOGICAL SURGERY IN CORONAVIRUS DISEASE 2019 POSITIVE OR SUSPECTED PATIENT

An important consideration in the era of COVID-19 is when and how to intervene. Patients infected with COVID-19 have a substantial risk of complications and even death. In a retrospective study, a 20% mortality was noted in patients undergoing nonurological surgery during the incubation period of COVID-19, and 44% mortality in those admitted to intensive care unit (ICU) [14]. These high morbidity and mortality rates should be taken into consideration while weighing risks and benefits of emergency surgery in COVID-19-positive patients. Ficarra et al. [15] suggested that the only procedures that might be needed in patients with urological stone related emergencies and simultaneous COVID-19 infection are placement of nephrostomy tubes or ureteral stents.

Concerning techniques of double J stent insertion, a pilot study performed by Yang et al. [16] in eight patients explored a variation in which ultrasound was used to facilitate bedside placement of ureteral stents. Patients with hemodynamic instability, altered mental status, history of renal transplantation, and pregnancy were not offered a bedside procedure. The benefits of such interventions include the ability to avoid general anesthesia and endotracheal tube aerosolization, safe performance of the procedure in patients with uncertain COVID-19 status, no radiation exposure, and no need for PACU monitoring. Moreover, the cost of performing stent insertion with bedside ultrasound was shown to decrease from US \$10 000 to US \$4000. Ultrasonography was performed by either the ultrasound technician or urologist and achieved an 88% success rate. It is important that this technique was described in a small nonrandomized case series by a single operator and should be performed only with centers and surgeons comfortable with implementing it and is not meant to be done routinely.

In terms of preoperative assessment, a COVID-19 PCR test should be administered within 48 h preoperatively to patients planned for surgery [13]. It is recommended to wear full Personal Protective Equipment for COVID-19-positive patients according to the World Health Organization (WHO), which includes double gloves, gowns, face shields, and virus-proof masks [33]. EAU guidelines also recommend that the irrigation fluid evacuated during endourological management should be collected through a closed system to minimize contamination and potential exposure to virus [17].

IMPACT OF PANDEMIC ON DEFINITIVE STONE MANAGEMENT

Multiple strategies and technicalities have been proposed to reduce the risk of hospital visits during the pandemic. Various triage algorithms recommended delaying the definitive treatment of nonurgent nephrolithiasis beyond 12 weeks during pandemic surge. These include patient with asymptomatic/ nonobstructing stones, those needing percutaneous nephrolithotomies (PCNLs) in general, patients with stents/nephrostomy tubes, and asymptomatic bladder stones [11,15,18^{••},19^{••}]. It was suggested to postpone replacement of ureteral stents and nephrostomy tubes for up to 6 months [15]. Likewise, it was also suggested to delay most procedures in patients with indwelling stents, as there is evidence that most stents left in place for up-to 6–12 months can be removed uneventfully with an outpatient procedure [10]. However, while doing so, one should be aware of risks associated in keeping indwelling stents or nephrostomy tubes for longer periods. A prospective study done in the pre-COVID-19 era noted that duration of indwelling stent was a significant risk factor for post-URS sepsis [20]. Based on these findings, the authors recommended that stent placement should be considered cautiously, and if used, definitive URS should be performed within 1 month.

Keeping the risk of long-dwelling ureteral stents in mind, the option of omitting post procedure stent placement was also explored during the pandemic. Kachroo et al. [21] noted that during the COVID-19 era their rate of stent omission increased from 12% to 66%. Similarly, their rate of leaving stents with strings increased from 7% to 16% in the post-COVID-19 era. Interestingly authors found that none of their patients had any complications requiring ED visits that were attributable to changes made in their stent policy. Based on these results, keeping the stent string is encouraged as it would allow the patient to remove the stent at home, thereby reducing the need for a clinical visit. Other strategies that were explored to reduce concerns related to long term placement of indwelling ureteral stents include use of a silicone stent instead of a polyurethane stent to minimize risk of encrustation [20]. This strategy should assist in safely spacing out healthcare visits during pandemic.

The Michigan Urological Surgery Improvement Collaborative (MUSIC) had proposed the use of shock wave lithotripsy (SWL) instead of URS when feasible for treatment of nephrolithiasis. According to their study ED visits post procedure were 3.5% for SWL versus 7.7% for URS procedures. Another reason to prefer SWL includes feasibility to perform procedure without general anesthesia and intubation, ability to avoid stent insertion and thereby an extra visit for removal, and overall lower unplanned healthcare utilization of personnel and resources [22[•]].

Although laparoscopy for nephrolithiasis is quite a rare approach it should be performed with caution if unavoidable. Puliatti *et al.* [23] reported that COVID-19 viral particles were viable in aerosols for up to 3 h raising concern of possible risk to healthcare workers due to pneumoperitoneum. Although there is no evidence to date indicating presence of viable virus in surgical smoke, it is recommended that one should use the lowest pneumoperitoneum pressure possible, include exhaust filtration devices, use the lowest power energy settings, and ensure complete desufflation of abdomen at the conclusion of the procedure.

The pandemic has also impacted anesthesia practice in general. In a survey, only 38% of respondents would continue using general anesthesia during the COVID-19 pandemic and 34% preferred spinal over general anesthesia. Since multiple studies have confirmed safety of spinal/regional anesthesia for stone treatment in the past, it is recommended that endourologists should prefer regional anesthesia during the pandemic whenever possible [12].

Triage algorithms

Multiple algorithms were proposed to triage patients for definitive surgical management during the surge of COVID-19 infected patients. Metzler *et al.* [18^{••}] proposed an algorithm to triage patients according to certain parameters. In general, septic shock secondary to an obstructing stone or a complete obstruction of the collecting system bilaterally (or unilaterally in a solitary kidney) would warrant urgent intervention within <24 h (Table 1). Similarly, Stensland *et al.* [2,10] also recommend emergent intervention for nephrolithiasis only in the setting of obstruction and infection.

Goldman and Haber [18^{••}] classified urological operations into five tiers. Ureteral stones were placed in tier 1, meaning that these patients could be treated and scheduled in routine manner. Symptomatic stones or those with indwelling stents or nephrostomy tubes were classified as tier 3, and their treatment could be delayed for 1–3 months. Asymptomatic nonobstructing stones were classified as tier 4, and their treatment able to be delayed for

Table 1. Detailed triage algorithms as proposed by different medical centers		
	University of Washington (Metzler <i>et al.</i> [15])	Cleveland Clinic (Goldman and Haber [16])
0 – Emergent (<24 h)	 Obstruction + infection Obstruction in solitary kidney or bilateral kidneys Intractable symptoms requiring admission 	- Obstructed kidney + infection
1 – Urgent (2–4 weeks)	 Obstruction failed MET or too large to pass Symptomatic not controlled with meds/ recurrent ED visits Obstruction + AKI Recurrent UTIs due to stones despite adequate drainage 	- Ureteral stone
2 – Short wait (<4–8 weeks)	 Ureteral stone failed MET but symptoms controlled Stone with stent but bothersome symptoms Recurrent UTIs in nonobstructing renal stones requiring suppressive antibiotics 	- Stent exchange required
3 – Long wait (<9–12 weeks)	- Stone with stent and tolerable symptoms	 Stone with stent/nephrostomy tube or symptomatic
4 – Postpone	 Asymptomatic nonobstructing renal stones Majority of PCNL cases 	- Asymptomatic nonobstructing renal stones

Source: Metzler IS, Sorensen MD, Sweet RM, Harper JD. Stone care triage during COVID-19 at the University of Washington. J Endourol. 2020; 34(5):539–540 and Goldman HB, Haber GP. Recommendations for tiered stratification of urological surgery urgency in the COVID-19 era. J Urol. 2020. doi: 10.1097/JU.000000000001067.

AKI, acute kidney injury; ED, emergency department; PCNL, percutaneous nephrolithotomies; UTI, urinary tract infection.

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>3 months. Stent exchange was classified as tier 2 and could be delayed for up to 4 weeks. Proietti *et al.* [11] also provided a triage algorithm for scheduling stone patients for surgery emphasizing emergent need in the setting of complete obstruction, intractable symptoms, obstructive urosepsis, and impaired kidney function.

EAU guidelines [17] categorized patients as high priority for elective surgeries if a delay of more than 6 weeks would lead to harm and emergency priority in patients with organ or life-threatening status. They only recommended treating these cases during COVID-19 pandemic. Patients in whom clinical harm would be unlikely if definitive treatment was postponed for 6 months were categorized as low priority and those with clinical harm possible but unlikely if definitive treatment postponed for 3– 4 months as intermediate risk.

IMPACT OF PANDEMIC ON OUTPATIENT MANAGEMENT OF PATIENTS WITH NEPHROLITHIASIS

Luciani *et al.* [24] have reported that during the start of the pandemic 45% of patients cancelled their in person appointments without rescheduling. Over a 4 weeks span, in-person visits decreased from 63% to 9%. Seventy-four percentage of those in-person visits were concerning new onset malignancy or severe LUTS, infection and complicated stones. They proposed that telemedicine is an efficient way to screen patients and protect patients and clinicians from exposure to COVID-19. A survey of 60 physicians from 20 European countries revealed that 49% experienced a radical change in practice, and 72.3% of those physicians endorsed telemedicine [12]. Kachroo *et al.* [21[•]] similarly reported a shift to telehealth during the pandemic from 0 to 94% of their patients.

Although telehealth visits and video communication were utilized before the pandemic, COVID-19 incentivized physicians to explore its utility and rely on its functionality. A key factor for success in dealing with the pandemic is social distancing and hence telehealth thrived. The US government including insurance companies and, in particular, Medicare and Medicaid, have supported reimbursement of telehealth visits during the beginning of the pandemic in order to encourage social distancing [25]. Benefits of telehealth include minimizing virus exposure (to healthcare workers and patients) and resource utilization, as well as increasing ease of accessibility for patients.

According to MUSIC, 98% of urologists reported that telehealth was sufficient, and that nephrolithiasis was the most common urologic condition presenting to telehealth [22[•]]. Lack of same day

imaging might be considered a drawback of telehealth visits. Hughes *et al.* [26^{•••}] described a virtual stone clinic (VSC) to follow-up patients diagnosed with urolithiasis in the United Kingdom. In their prospective study, regular presentations to VSC included asymptomatic renal stones (79.3%) and recurrent stones (15.5%). The VSC was able to accept 99.3% of patients with only 2.8% noncompliance and 8.2% of patients lost to follow up. They also reported 93% cost reduction. Following virtual encounters patients could be discharged successfully and later return for face to face follow up or surgical intervention as indicated. The main limitation of this study was it did not investigate impact of evaluating new patients with urolithiasis in VSC.

IMPACT OF PRIOR CORONAVIRUS DISEASE 2019 INFECTION ON LONG-TERM CARE OF NEPHROLITHIASIS PATIENTS

COVID-19 is a novel strain of coronavirus whose pathophysiology and long-term effects on various human organs are still being discovered. The virus has strong affinity to Angiotensin Converting Enzyme - 2 (ACE-2) receptors [23]. It is estimated that 2.4% of bladder urothelium and 4% of proximal convoluted tubule cells have ACE-2 receptors [23]. These receptors are mainly appreciated on the brush border of the proximal convoluted tubules [27]. Hence, COVID-19 can infect the kidney and cause significant acute kidney injury (AKI). The virus may infect the kidney directly and might result in up to 91.7% mortality rate [28].

Prevalence of AKI was found in 17% patients with COVID-19 infection in one meta-analysis. About 77% of patients with AKI experienced severe COVID-19 infection and 54% died [29]. Thirty-five percentage of patients noted a decrease in estimated Glomerular Filtration Rate (eGFR) 6 months post-COVID-19 infection [29]. Interestingly, 13% of patients who were infected and hospitalized for COVID-19 and who did not have any acute kidney injury during their hospitalization showed a reduction in eGFR during follow up [30]. It is estimated that 5–9% of patients hospitalized with COVID-19 will receive renal replacement therapy. It is also observed that 40% of hospitalized patients due to COVID-19 have proteinuria and hematuria [29].

It is still unknown how the impact of COVID-19 on renal tissue would alter renal function long-term in patients with simultaneous nephrolithiasis. It is possible that patients with history of nephrolithiasis might be at high risk for renal deterioration after COVID-19 infection. Similarly, long-term effects of COVID-19 infection on renal metabolism have yet to be determined. The possibility that this might alter renal metabolites and alter stone risk profile results in patients with prior COVID-19 infection should be a topic of future research.

There is also increasing evidence in the literature that some patients infected with severe acute respiratory syndrome - coronavirus 2 (SARS-CoV-2) do not successfully clear the virus over long periods of time [34–36]. Viral DNA was detected in 6.9% of patients post COVID-19 recovery even after their throat swabs were negative [30]. These authors noted delayed clearance of virus in patients who receive glucocorticoids. The risk of elective surgery for nephrolithiasis in these patients with a negative naso-pharyngeal PCR test is unknown.

With regards to urinary contamination, it is safe to treat urologic patients with regular sterilization of instruments before reuse [31]. A study analyzing 72 urine samples from 205 patients with COVID-19 revealed that none of the urine samples were positive [32]. There is no available evidence to support urinary transmission of the COVID-19 virus [23].

CONCLUSION

Given the risk of novel viral pandemics in the future, the endourology community should be aware of possible alterations in clinical practice. Proper triage of emergent cases, use of telehealth whenever sufficient and possible, understanding the implications of COVID-19 infections in nephrolithiasis patients, and addressing definitive stone management with reasonable timing are all vital strategies to optimize kidney stone patient care in the setting of COVID-19 pandemic. Although various new ideas for nephrolithiasis management are emerging in such a setting, further research is needed to validate their effectiveness and fine tune their implementation.

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Conflicts of interest

There are no conflicts of interest.

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Social distancing with telehealth along with the drastic shift and the success with doing so is assessed prospectively and discussed.

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