Urologia Internationalis

Research Article

Urol Int
DOI: 10.1159/000543644

Received: June 25, 2024
Accepted: December 31, 2024
Published online: January 30, 2025

Impact of Personnel Scarcity on Urolithiasis Treatment: A Comparative Study of the Pre- and Post-Pandemic Eras

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Keywords
Ureterorenoscopy · Laser lithotripsy · Urolithiasis · Waiting time · Complication · Personnel scarcity

Abstract
Introduction: This research investigates the influence of the medical personnel shortage on the treatment of urolithiasis by comparing the complication rates in patients with urinary stones who undergo ureterorenoscopy with laser lithotripsy before and after the emergence of this unprecedented situation. ***Methods:*** A total of 160 patients undergoing ureterorenoscopy with laser lithotripsy for urolithiasis were retrospectively evaluated, segmented into pre- and post-pandemic cohorts. Complications that occurred preoperatively (during the waiting period for operation), intraoperatively, and postoperatively were documented to compare the complication rates between the two cohorts. ***Results:*** The investigation demonstrated a significant elevation of complications during the preoperative waiting period in the post-pandemic cohort ($p < 0.001$), concurrent with a substantial increase in the median waiting time from 20 days to 94 days ($p < 0.001$). No significant differences were present in intra- and postoperative complications between the two cohorts. ***Conclusion:*** In the new era of personnel shortage, increased complication rates during the preoperative waiting time were observed, concomitant with a significant increase in the waiting times for surgery. This novel challenge of increased preoperative morbidity also led to additional resource consumption. It is imperative to adapt the therapeutic landscape of urolithiasis to the new circumstances.

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Introduction

The healthcare system has undergone significant changes in past years, especially in the aftermath of the global COVID-19 pandemic, which led to considerable implications for the management of various diseases, including urolithiasis. The scarcity of healthcare personnel in many regions has resulted in extended waiting times for elective operations [1], thereby affecting timely access to treatment. During the course of the pandemic, the decision to postpone elective surgeries demonstrated a detrimental effect on their outcomes, leading to the development of triage strategies [2, 3]. However, as the pandemic subsides and triage systems are phased out, the persisting shortage of healthcare personnel presents a novel and unparalleled limitation to healthcare delivery in the Western world [4].

Urolithiasis, a common condition in urological practice, can precipitate emergencies and adversely impact long-term renal function, especially when accompanied by urinary infections or renal failure [5]. Retrograde ureteral catheterization and percutaneous nephrostomy effectively relieve obstruction and infection in urolithiasis [6]. Although these procedures can relieve the emergency, definitive stone treatment should ideally be conducted following the resolution of the acute phase [7]. After the onset of personnel shortages following the pandemic, the waiting times for urolithiasis surgeries have also increased [8], thereby necessitating the integration of these delays into clinical decision-making. Consequently, this study aimed to evaluate and compare the complications experienced by patients undergoing ureterorenoscopy (URS) with laser lithotripsy for urolithiasis before and after the emergence of the new personnel shortage situation.

Methods

Institutional Review Board approval was obtained prior to data collection (IRB # 1836/2023). This study was a retrospective comparative investigation of URS with laser lithotripsy in the pre- and post-pandemic eras, which included a total of 160 patients who underwent elective URS with laser lithotripsy treatment for urolithiasis in our clinic. The study population was divided into two cohorts for comparison, categorized based on the treatment period: the pre-pandemic group (patients treated in 2018) and the post-pandemic group (patients treated in 2023). Each cohort comprised the first 80 consecutive patients treated in the specified year. The operations were performed with a 8/9.8 Fr semirigid ureteroscope (Richard Wolf™, Knittlingen, Germany) for ureteral stones or flexible ureteroscope (LithoVue™ 8.9 Fr, Boston Scientific, Marlborough, MA, USA, and Pusen UScope™ 7.5 Fr, Guangdong, PRC) for kidney stones. The utilized ureteral stents were hydrophilic DJ stents (Rüsch 7 Fr, Teleflex, Wayne, PA, USA).

A non-contrast-enhanced computed tomography was performed preoperatively in all of the operated patients as the standard operating procedure in our clinic [7]. The postoperative stone-free rate was based on the operation report of the surgeon. In all recruited patients, American Society of Anesthesiologists (ASA) score, urine culture, presence of cardiovascular disease, hydronephrosis at initial presentation, creatinine value, presence of prestenting, diameter of the primary stone, quantity of the urinary stones, stone position, and bilaterality of the stone disease were evaluated. Patients with documented anatomical anomalies of the urinary tract, primary URS with laser lithotripsy at the initial presentation, concurrent operations, or planned operations within 30 days before or after URS with laser lithotripsy were not included in this study. Patients exhibiting positive urine culture results received concordant antibiotic therapy prior to surgery. The standard perioperative antibiotic prophylaxis was performed with a single-dose 3 g intravenous cefuroxime axetil in non-symptomatic and culture-negative subjects. Patients with a hydronephrosis were decompressed with a ureteral stent. Patients presenting with urinary tract infection (UTI) received appropriate intravenous antibiotics. The waiting time for the operation was extracted from the waiting list of our department. In the pre-pandemic era, the urological department of the Vienna General Hospital had four operation theaters for elective urological surgeries. In the post-pandemic era, the number of operation theaters was reduced to two.

The categorization and reporting of the complications were performed in line with the urological surgery reporting of Mitropoulos et al. [9] and with the URS Global Study of Somani et al. [10]. Moreover, complications were classified based on the timing of their occurrence into three distinct categories: preoperative waiting period complications, intraoperative complications, and postoperative complications. Preoperative waiting time was defined as the timeframe from the initial presentation of the patient at our clinic to the definitive operative treatment of the urinary stone disease. Observed preoperative waiting period complications and postoperative complications were hematuria, stent migration, UTI, febrile urinary tract infection (fUTI), and renal colic. In

our series, intraoperative complications were graded according to modified Satava Classification as described by Tepeler et al. [11]. Additionally, postoperative complications were systematically categorized using the modified Clavien-Dindo classification [12].

Stent encrustation rates were evaluated separately from complications due to its lack of immediate clinical relevance. Readmissions, reoperations, and incomplete operations were documented with the underlying causes. Operational distinctions, such as length of hospital stay, were also scrutinized to address disparities in procedural facets. Patients were routinely followed up to 8 weeks after surgery.

Statistical Methods

All statistical analyses were conducted using SPSS software, version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics for both cohorts were compared to identify any potential confounding differences. *t* tests were used for continuous variables such as age, creatinine levels, number, and size of kidney stones. The chi-square or Fisher's exact tests examined categorical variables like gender, cardiovascular disease, ASA classification, hydronephrosis, stone bilaterality, and preoperative stent placement. This study primarily focused on comparing complication rates during different phases: preoperative waiting time, intraoperative, and postoperative, using *t* tests. The assessment of the two cohorts regarding the procedural outcomes, including stone-free rates and readmission rates, was assessed with chi-square tests. The post hoc power analysis of the study, based on the increase in complication rates during the preoperative waiting time and taking an alpha level of 0.05, was calculated to be 99.96%. A p value of less than 0.05 was considered as statistical significance.

Results

Upon evaluating the two cohorts from pre- and post-pandemic eras, encompassing 80 patients each, no significant differences were detected in baseline demographics including age, gender, and ASA scores ($p > 0.05$). The median age was 55 years across both groups, and the distribution of cardiovascular disease presence, hydronephrosis at initial presentation, and preoperative double-J placement did not show statistical differences ($p > 0.05$). Patients in the post-pandemic cohort had significantly longer waiting times for the URS with an average of 94 days compared to the pre-pandemic cohort with an average waiting time of 20 days ($p < 0.001$). The baseline demographic findings of the patients are summarized in Table 1.

Among the three assessed time frames for complications (preoperative waiting time, intraoperative, postoperative), only significant difference was observed in the preoperative waiting time complication rates between the two cohorts, as shown in Table 2. In the post-pandemic group, a significant increase in complications during the preoperative waiting period was observed compared to the pre-pandemic group ($p < 0.001$). Specifically, rates of renal colic, UTI, and fUTI escalated substantially in the post-pandemic cohort ($p_{\text{renalcolic}} < 0.001$, $p_{\text{UTI}} = 0.0.03$, $p_{\text{fUTI}} < 0.001$). Accordingly, in the post-pandemic cohort, 14 hospital readmissions were recorded during the preoperative waiting time for the surgery, while in the pre-pandemic group only two hospital readmissions were recorded during the preoperative waiting time ($p < 0.001$), as shown in Table 3. All of the 14 hospital admissions in the post-pandemic group during the preoperative waiting period necessitated stent (re-)placements, with 10 stent replacements, and four were new placements of ureteral stents. Of these, 12 out of 14 operations were prompted by UTI or febrile UTI, while the remaining two were due to renal colic alone. The median time to stent replacement in the post-pandemic cohort was 61 days after the initial stent placement. In line with these findings, a significant increase in the encrustation rates of the ureteral stents was observed in the post-pandemic cohort ($p < 0.001$). The only readmission and stent replacement in the pre-pandemic cohort during the preoperative waiting time was also due to an fUTI, which took place 20 days following the initial placement.

In contrast, intraoperative complications did not significantly differ between groups ($p > 0.05$). Similarly, postoperative complications, including specific complications such as fUTI or hematuria, presented no significant variation ($p > 0.05$). Hematuria were managed with bladder irrigation; no blood transfusion was needed in both cohorts (Table 4). All minor postoperative complications were managed with according medication, such as antipyretics or antibiotics. One patient with a postoperative fUTI progressed to urosepsis and required intensive care in the post-pandemic cohort (Clavien-Dindo 4) (Table 5). This patient was discharged after 12 days of inpatient care in stable condition. No mortality was observed in either cohort.

The mean postoperative length of stay was statistically similar between the two groups ($p = 0.748$). Also, the rates of postoperative readmission and stone-free rates were not significantly different between the groups ($p = 0.443$ and $p = 0.13$, respectively).

Table 1. Descriptives

Variables	Pre-pandemic cohort (n = 80)	Post-pandemic cohort (n = 80)	p value
Age, median (SD), years	55 (15.06)	55 (14.57)	0.136
Gender, n (%)			0.746
Female	30 (37.5)	32 (40)	
Male	50 (62.5)	48 (60)	
ASA, mean (SD)[a]	2.03 (0.45)	2.1 (0.44)	0.322
Presence of cardiovascular disease, n (%)	44/80 (55)	43/80 (53.8)	0.874
Creatinine at first visit, median (SD), mg/dL	0.9 (0.3)	0.9 (0.25)	0.373
Hydronephrosis at initial presentation, n (%)	44/80 (55)	46/80 (57.5)	0.928
Preoperative double-J placement, n (%)	48/80 (60)	49/80 (61.25)	0.871
Presence of bilateral stone disease, n (%)	4/80 (5)	7/80 (8.75)	0.349
Quantity of relevant urinary stones, mean (SD)	1.66 (0.88)	1.82 (0.91)	0.279
Diameter of the primary stone, median (SD), mm	10 (2.82)	10 (5.14)	0.128
Ureter stone, n (%)	47/80 (58.75)	50/80 (62.5)	0.626

SD, standard deviation. [a]American Society of Anesthesiologists score.

Table 2. Complications during the preoperative waiting time

Variables	Pre-pandemic cohort (n = 80)	Post-pandemic cohort (n = 80)	p value
Preoperative complications during the waiting time, mean per patient (SD)	0.08 (0.31)	0.54 (0.70)	<**0.001**
Nausea	3/80 (3.75)	3/80 (3.75)	1
Stent migration	0/80 (0)	3/80 (3.75)	0.08
Renal colic	1/80 (1.25)	14/80 (17.5)	<**0.001**
UTI	1/80 (1.25)	11/80 (13.75)	**0.003**
fUTI	1/80 (1.25)	13/80 (16.25)	<**0.001**

Text in bold denotes statistically significant findings. Specific complications were reported in the format n (%). SD, standard deviation.

Discussion

During the pandemic, various centers have reported a reduction in elective surgical capacity, which has had significant effects on different therapeutic landscapes, including the treatment of urolithiasis [13]. A recent survey showed that only 6.4% participants continued their elective surgical treatment approach as before the pandemic in patients with urolithiasis [14]. Along with a decrease in the overall quantity of elective operations for urolithiasis, also a decrease in the specific quantity of performed URS procedures was reported [15]. Due to the reduction in the operation capacity, many centers reported prolonged waiting times for elective urolithiasis procedures [13, 16]. The influence of the pandemic and reduced operation capacity on the complication rates was ambiguous in the literature, probably reflecting the differences in the implications of the pandemic across different urological settings. For instance, Medina et al. [16] reported a significant increase in the postoperative complication rates after elective stone surgery during the pandemic, which was observed with a concomitant significant increase in the waiting times for the operative treatment. A retrospective study by Gul et al. [17] demonstrated that the rate of

Table 3. Procedural outcomes

Variables	Pre-pandemic cohort (n = 80)	Post-pandemic cohort (n = 80)	p value
Waiting time, average (SD), days	20 (18.7)	94 (55.04)	<**0.001**
Operation duration, average (SD), min	55 (25)	59 (48)	0.056
Hospital admissions during the *preoperative* waiting time for definitive surgery, n (%)	1/80 (1.25)	14/80 (17.5)	**0.002**
Hospital readmissions in the *postoperative* phase, n (%)	2/80 (2.5)	3/80 (3.75)	0.650
Stent (re-)placement during waiting period, n (%)	1/80 (1.25)	14/80 (17.5)	< **0.001**
Postoperative length of stay, mean (SD), days	2 (0.87)	2 (0.56)	0.748
Encrustation of the ureteral stent, n (%)	1/48 (2.1)	11/49 (22.45)	**0.002**
Preoperative significant urinary culture before the URS treatment, n (%)	10/80 (12.5)	31/80 (38.75)	<**0.001**
Stone-free rate, n (%)	66/80 (82.5)	58/80 (72.5)	0.13

Text in bold denotes statistically significant findings. Preoperative significant urinary culture was defined as detection of uropathogenic microorganisms in the preoperative urine culture, quantity $\geq 10^3$ CFU. Overall hospitalization duration encompasses both the postoperative stays after URS procedures and the stays resulting from readmissions. Stone-free rate is based on operation reports of the surgeons. SD, standard deviation.

Table 4. Intraoperative complications according to Satava Classification

Variables	Pre-pandemic cohort (n = 80)	Post-pandemic cohort (n = 80)	p value
Grade 1 complications (incidents without consequences)	3/80 (3.75%)	3/80 (3.75%)	1
Mild bleeding	3/80 (3.75%)	3/80 (3.75%)	1
Grade 2 complications (incidents treated with endoscopic surgery)	8/80 (10%)	15/80 (18.75%)	0.14
Grade 2a complications (incidents treated intraoperatively with endoscopic surgery)	3/80 (3.75%)	8/80 (10%)	0.13
Proximal stone migration requiring stent insertion±shockwave lithotripsy	1/80 (1.25%)	2/80 (2.5%)	0.56
Proximal stone migration treated with flexible ureteroscopy or percutaneous nephrolithotomy in the same session	1/80 (1.25%)	4/80 (5%)	0.19
Inability to reach stone requiring stent insertion ± shockwave lithotripsy	1/80 (1.25%)	2/80 (2.5%)	0.56
Grade 2b complications (incidents requiring endoscopic re-treatment)	5/80 (6.25%)	7/80 (8.75%)	0.56
Proximal stone migration requiring secondary flexible ureteroscopy or percutaneous nephrolithotomy	1/80 (1.25%)	2/80 (2.5%)	0.56
Inability to access ureter or reach stone requiring secondary ureteroscopy	2/80 (2.5%)	2/80 (2.5%)	1

complicated kidney stone disease significantly increased during the COVID-19 pandemic. Flammia et al. [18] also demonstrated increased rates of complicated urinary stones during the pandemic in line with Gul et al. [17], yet they observed no increase in the complication rates. Conversely, some studies reported that treatment outcomes and postoperative complication rates did not change during and after the pandemic [15, 18, 19]. Two current studies both reported a decrease in the treatment capacity, yet these studies found no increase in the complication rates after the onset of the pandemic [15, 19]. Notably, literature lacks an evaluation of the influence of extended waiting times on the preoperative complications during the waiting time for definitive treatment. However,

Table 5. Postoperative complications according to modified Clavien-Dindo classification

Variables	Pre-pandemic cohort (n = 80)	Post-pandemic cohort (n = 80)	p value
Clavien-Dindo grade 1	3/80 (3.75%)	5/80 (6.25%)	0.48
Hematuria	2/80 (2.5%)	4/80 (5%)	0.41
Nausea	1/80 (1.25%)	1/80 (1.25%)	1.0
Clavien-Dindo grade 2	3/80 (3.75%)	4/80 (5%)	0.71
Renal colic	1/80 (1.25%)	2/80 (2.5%)	0.56
UTI	2/80 (2.5%)	1/80 (1.25%)	0.56
Brief psychotic disorder	0/80 (0%)	1/80 (1.25%)	0.32
Clavien-Dindo grade 3	1/80 (1.25%)	2/80 (2.5%)	0.56
Stent migration	0/80 (0%)	1/80 (1.25%)	0.32
Aspiration pneumonia	0/80 (0%)	1/80 (1.25%)	0.32
Clavien-Dindo grade 4	0/80 (0%)	1/80 (1.25%)	0.32
fUTI	0/80 (0%)	1/80 (1.25%)	0.32

these preoperative complications during the waiting time were the basis of the triage systems that were used to stratify urolithiasis patients during the pandemic [2]. To our best knowledge, this is the only study assessing the impact of the personnel shortage on the complications during the waiting time for surgery.

Despite the pandemic receding, the shortages in resources and medical staff arose during that period persist, continuing to restrict the therapeutic landscape of urinary stone disease [4, 20]. Most of the strategies developed in that period are outdated as they took an active COVID-19 pandemic into consideration and aimed to minimize the risk of COVID-19 transmission. The current medical personnel shortage has recently been described as a "permacrisis" by Burau et al. [21], characterized by sustained resource and personnel deficiencies. The heavy workload during the pandemic precipitated an exodus of healthcare personnel from the profession. This situation is anticipated to be enduring as a global shortage of healthcare personnel is predicted for the coming years [22, 23]. Learning from the resource allocation challenges faced during the pandemic may provide strategic insights for the macro-level management of healthcare systems in the future [24]. Yet, as this novel circumstance of resource scarcity is expected to become the norm, it is necessary to evaluate the implications of the current constraints across all facets of urolithiasis treatment, including the pre- and postoperative phases, to provide the best possible treatment and ensure maximum resource efficiency.

In our study, no increase in the postoperative or intraoperative complications was observed in our post-pandemic cohort, which was subjected to substantially longer waiting times, which is in contrast with the findings of the previous studies as we mentioned above [15, 19]. However, a notable rise in the preoperative complications during the waiting period was observed within the post-pandemic cohort, highlighting an unaddressed obstacle in the era of personnel scarcity. Due to the significant increases in the rates of the preoperative complications such as UTI, fUTI, or pain/colic, a decrease in the quality of healthcare delivery can be suggested in the post-pandemic cohort. Remarkably, 17.5% of the patients in the post-pandemic cohort had to be readmitted for inpatient treatment due to major complications during the waiting time. It is evident that this situation places an additional strain on a healthcare system already grappling with limited resources. In addition to the triage strategies, various alternative approaches were suggested to minimize the resource consumption. Adopting primary URS could be suggested as a viable approach, as its feasibility was demonstrated in several studies [25, 26], and it has been reported to provide similar outcomes with pre-stenting in a single center report [26]. In some studies, extracorporeal shockwave lithotripsy was also suggested to provide similar outcomes to URS with the aim of preserving hospital resources and limiting opportunity for virus transmission [27, 28]. A recent meta-analysis reported that early extracorporeal shockwave lithotripsy and URS appear to be safe interventions for patients with urolithiasis during the COVID-19 pandemic. However, this analysis did not evaluate the long-term outcomes due to an absence of data [29]. It should be underlined that the choice of treatment modality is also based on the availability of resources, which might vary among different settings, especially in the new era of personnel shortage following the pandemic [30].

A few limitations of this study must be noted. First, this study was conducted in a single center and relying on retrospective data is constrained by a sample size of 160

patients. Second, due to the absence of prior literature on this unprecedented scenario, the statistical explanatory strength of this study is uncertain, leaving the possibility that certain implications may remain undisclosed. To overcome these limitations and gain a more comprehensive understanding of challenges associated with prolonged waiting times, insights from diverse clinical settings or multicentric analyses could provide valuable perspectives. Moreover, despite finding no significant differences in intra- and postoperative complication rates, it is noteworthy that the potential variability in surgical expertise across the two cohorts has not been addressed, which might also affect the outcomes. Given that urolithiasis imposes a significant symptomatic burden, it is important to incorporate considerations related to the quality of life into regular assessments. It should be noted that this aspect was not evaluated in the present study.

Conclusion

This study demonstrates an increase in complications during the preoperative waiting period among urolithiasis patients in the post-pandemic era, along with prolonged waiting times for surgery. There was no increase in intra- or postoperative complications compared to the pre-pandemic timeframe. With an increased rate of hospital readmissions and longer overall hospitalization durations in the post-pandemic group, the resource scarcity situation poses an additional burden on the healthcare system, which already operates at reduced capacity. More importantly, the increase in preoperative complications highlights a clear negative effect on patient well-being, highlighting the serious impact of resource shortages on the quality of patient care. As the personnel scarcity situation is expected to become the new norm, urolithiasis treatment strategies must be adapted to this emerging reality.

Statement of Ethics

This research was conducted according to the guidelines of the Declaration of Helsinki. The Ethics Committee of the Medical University of Vienna approved the study (Approval Date: 07.11.2023, IRB Decision Number: 1836/2023). The need for informed consent was waived by the Ethics Committee of the Medical University of Vienna.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

There was no funding of this study.

Author Contributions

Ozan Yurdakul: writing – original draft, writing – review and editing, data curation, formal analysis, and investigation. Christian Seitz: conceptualization, writing – review and editing, and project administration. Altug Tuncel: writing – review and editing, formal analysis, and investigation. Julian Veser and Melanie Hassler: investigation. Shahrokh Shariat: supervision and writing – review and editing. Mesut Remzi: supervision, investigation, methodology, and writing – review and editing.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author. A preprint version of this article is available on Research Square [31] (Ozan Yurdakul, Christian Seitz, Julian Veser, Melanie Hassler, Shahrokh Shariat, Mesut Remzi, Impact of Personnel Scarcity on Urolithiasis Treatment: A Comparative Study of the Pre- and Post-Pandemic Eras, https://doi.org/10.21203/rs.3.rs-3839554/v1 [Preprint], Jan 10, 2024).

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