Single-use flexible ureteroscopic treatment for large renal lithiasis

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ABSTRACT

With a lifetime frequency of 10% in people, renal stones are common, partly because of the rise of the prevalence of diabetes and obesity worldwide. The three current techniques for eliminating lower pole kidney stones are flexible ureterorenoscopy (FURS) with laser lithotripsy, extracorporeal shockwave lithotripsy (ESWL), and percutaneous nephrolithotomy (PCNL). The work aims to highlight the efficiency of single-use flexible ureteroscopy in the therapy of large renal lithiasis, taking into account aspects such as: post-interventional complications or re-interventions. The obtained data will then be compared with the data already existing in the literature.

This study represents a retrospective, descriptive, observational analysis of patients with large renal stones, between 2 and 4 centimeters in size. The study included 75 patients treated by single-use, unilateral flexible ureteroscopy, in the period 2023-2024. Success was defined as the absence of residual stone fragments larger than 3 mm at the end of the procedure. Perioperative and postoperative complications, stone-free rate, operation time, and length of hospital stay were analysed.

The mean operative tine of an intervention was 70.14 minutes. The therapeutic success rate was defined as the absence of the detection of lithiasis fragments or calculi larger than 3 millimeters in the computed tomography examination 30 days post-intervention. We can highlight an initial stone-free rate of 54.6% following a single intervention. The cumulative success rate increases substantially after a second intervention, reaching 94.6%, which proves the usefulness of the method when the protocol proposes to use it in a staged manner. Only 4 patients (a rest of 5.4% of the cases) presented calculi larger than 3 millimeters at the tomographic examination after 2 interventions. Among the recorded postoperative complications, encoutered 14 cases of Clavien 1 complications, and 6 cases of Clavien 2 complications. There were no complications compatible with Clavien class 3, but we mention the existence of a case of post-interventional sepsis (Clavien 4).

The results obtained following the evaluation of the patients studied encourage the extension of the indication of the analyzed technique to the treatment of large stones, especially considering the existing alternative, percutaneous nephrolithotomy, a method that involves a more significant morbidity. However, the therapeutic decision must remain a personalized one, with the integration of information related to the anatomy of the kidney, the size and location of the calculus and last but not least, the experience of the team involved.

Key Words: Flexible ureteroscopy, Large renal stones, Laser lithotripsy, Single-use ureteroscopy

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Introduction

With a lifetime frequency of 10% in people, renal stones are common, partly because of the rise of the prevalence of diabetes and obesity worldwide. Flank pain from stones (renal colic) is the most common cause of emergency admission to urology departments. The three current techniques for eliminating lower pole kidney stones are flexible ureterorenoscopy (FURS) with laser lithotripsy, extracorporeal shockwave lithotripsy (ESWL), and percutaneous nephrolithotomy (PCNL).[1,2]

For kidney stones larger than 2 cm in diameter, percutaneous nephrolithotomy (PCNL) is currently advised as the first-line treatment of choice [3]. Despite its great effectiveness, PCNL still has non-negligible morbidity consequences, such as organ damage, urinoma, and bleeding that necessitates angioembolization [4,5]. Thanks to technological developments with laser lithotripsy systems and novel endoscopic baskets, FURS helps urologists treat lower calyx stones or even complex renal stones through the natural orifice and contributes to an appropriate stone-free rate [6].

Recently, as a result of technological advances, a tendency of some authors to favor the use of ureteroscopy as first-line treatment in the case of large lithiasis can be observed. The known reasons are multiple, retrograde ureteroscopy being a minimally invasive technique with low morbidity and allowing a quick and safe post-intervention recovery. Technological evolution has led to the appearance of endoscopes with an improved deflection mechanism and smaller diameter, but also to the development of lasers with a fast and efficient disintegration capacity. Recently, single-use flexible ureteroscopes are emerging on the international market, with superior ergonomics due to lower mass compared to reusable ones and superior durability in terms of deflection capacity [8].

The work aims to highlight the efficiency of single-use flexible ureteroscopy in the therapy of large renal lithiasis, taking into account aspects such as: post-interventional complications or re-interventions. The obtained data will then be compared with the data already existing in the literature.

Material and method

This study represents a retrospective, descriptive, observational analysis of patients with large renal stones, between 2 and 4 centimeters in size, treated in the Urology department of the "Sfântul Ioan" Emergency Clinical Hospital, Bucharest. The study included 75 patients treated by single-use, unilateral flexible ureteroscopy, in the period 2023-2024.
The diagnostic protocol used for the present study was:
- Medical history
- Clinical examination
- Blood tests (complete blood count, uric acid, creatinine, urea, phosphateemia, calcium)
- Imaging (computed tomography, ultrasound, simple reno-vesical radiography, intravenous urography)
- Urine analyzes (urine summary, urine culture)

The inclusion criteria in the study were the following:
- CT diagnosis regarding the existence of a pyelo-calyceal calculus
- Patients with large renal lithiasis (having a lithiasis mass between 2 and 4 centimeters)

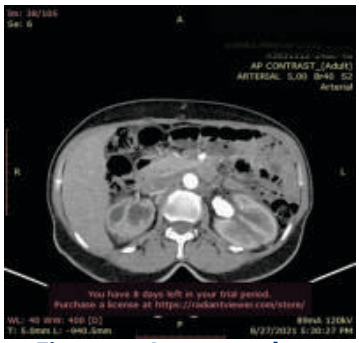


Figure 1 : Large renal stone

Exclusion criteria from the study:
- Patients with a different localization of lithiasis
- Small urinary stones (less than 2 centimeters)
- Patients under 18 years of age
- Pregnant patients

Success was defined as the absence of residual stone fragments larger than 3 mm at the end of the procedure.

Perioperative and postoperative complications, stone-free rate, operation time, and length of hospital stay were analysed.

Results

The presented study included the analysis of the course of a number of 75 patients with large renal lithiasis. Thus, we can mention the fact that 48 of the investigated patients had kidney stones with a diameter between 2 and 3 centimeters, the others (27 in number, almost 2 times less compared to the first category) had stones with a diameter of 3 to 4 centimeters. Percentage-wise, the first group represented 64% of the total, the remaining 36% summing up cases with a higher diameter, of 3-4 centimeters.



Figure 2 : 3D Reconstruction of a left renal stone

The maximum operative time set by the attending physician was 90 minutes, a limit imposed regardless of the achievement of post-interventional stone-free status to avoid infectious complications or ureteral lesions. The minimum time recorded was 49 minutes, at the opposite pole, with the longest intervention being 85 minutes. The average duration of an intervention was 70.14 minutes.

In the present study, the therapeutic success rate was defined as the absence of the detection of lithiasis fragments or calculi larger than 3 millimeters in the computed tomography examination 30 days post-intervention.

As a result of the analysis of the data presented above, we can highlight an initial stone-free rate of 54.6% following a single intervention. In other words, from the total of 75 patients whose evolutions were followed in the study, 41 had therapeutic success after a single procedure, while the remaining 34 (meaning approximately 45.4%) had to undergo additional procedures.

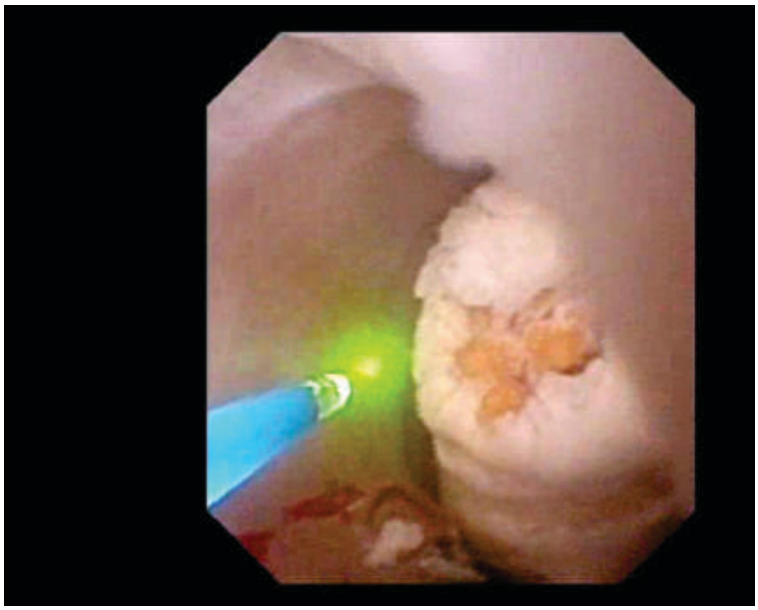


Figure 3 : Large renal stone treated by retrograde single-use flexible ureteroscopic approach

The cumulative success rate increases substantially after a second intervention, reaching 94.6%, which proves the usefulness of the method when the protocol proposes to use it in a staged manner. Only 4 patients (a rest of 5.4% of the cases) presented calculi larger than 3 millimeters at the tomographic examination after 2 interventions.

None of the patients had significant stone fragments detected after the third session (a therapeutic success rate of 100%), all patients achieving the stone-free goal.

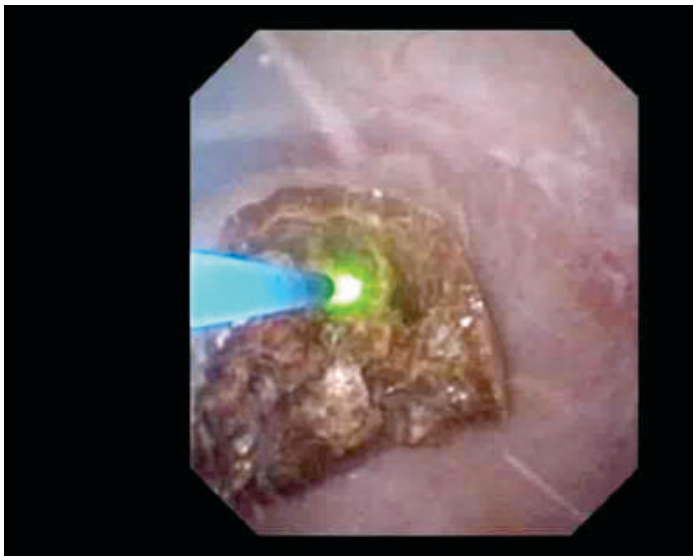


Figure 4 : Holmium laser lithotripsy of a large renal stone

The discussed study also tracked the incidence of post-interventional complications, classifying them according to Clavien. Among the recorded complications, we mention transient fever, self-limiting hematuria, nausea or vomiting, all of which belong to Clavien class 1. Among those analyzed, there were also cases whose complications could be classified as Clavien class 2, such as urinary infection with fever, severe post-interventional pain with the need for opioids, urinary retention with the need for the temporary fitting of a probe. The latter, unlike those with Clavien 1, needed specific treatment (antibiotic, analgesic, antipyretic).

In the study, there were no complications compatible with Clavien class 3, such as active bleeding or ureteral obstruction with double J stent placement, but we mention the existence of a case of post-interventional sepsis (Clavien 4).

Discussion

The study carried out during 2023-2024, in the urology clinic of the "Sfântul Ioan" Emergency Clinical Hospital in Bucharest, followed a group of 75 patients and aimed to evaluate the safety and results of the single-use flexible retrograde ureteroscopic approach in the treatment of large renal lithiasis. Thus, during the work we carried out an analysis of the data obtained on each case, following aspects considered essential in defining the safety profile and efficiency of the method in order to treat the aforementioned pathology, but also comparing these results with the information provided by the specialized literature.

The size of the stones in the studied group was also analyzed, the data obtained confirming the tendency to indicate the technique of flexible ureteroscopy in the case of moderate-large renal lithiasis. Thus, 48 of the patients included in the study (64% of the studied cases) presented stones with sizes between 2 and 3 centimeters, while the remaining 27 patients (36% of the total) had stones with a larger size, between 3 and 4 centimeters. The latter often raise technical problems such as longer operating times and staged interventions, although there is the possibility of endoscopic treatment in their case as well

The analysis of the duration of the ureteroscopic intervention surprised the fact that most patients were between 61 and 80 minutes, the peak being reached between 71 and 80 minutes (29 patients, a percentage of 38.6%). The average duration of the intervention was 70.14 minutes. The distribution presented suggests that single-use flexible ureteroscopic intervention involves a moderate-long operative time, on average, with variability depending on the anatomical complexity of the individual, complications and lithiasis size. The intervals from the two extremes, namely 49-60 minutes and 81-90 minutes, were recorded in much fewer cases, more precisely in 11 (14.6%) and 9 of the patients (12%). The explanation regarding the incidence of extreme intervals is given, in the case of the first interval, by the simple cases, with the presence of a single calculus, location or favorable anatomy, respectively by the complex cases, with multiple lithiasis, location difficult to approach or an unfavorable anatomy for the last interval.

It should be noted that in this study, the imposed limit was 90 minutes, a limit established in order to minimize the risk of post-interventional complications (sepsis being one of the examples). Only 9 patients, according to the data presented previously, fell within the range of proximity to the specified limit, a fact that suggests a good management of the duration of the interventions. The results regarding the distribution of patients according to operative time are in accordance with the specialized literature, one such example being the study published by Kuroda et al., in which a model was made to predict the operative time for the studied technique (flexible ureteroscopy) where factors such as the density and volume of the calculus, the preoperative use of the stent and the experience of the surgeon significantly influenced the duration of the intervention.[9] The aforementioned study revealed a positive correlation between calculus size and operative time, supporting our idea that high lithiasis burden is associated with longer operative times. The same study recommends limiting the operative time to 90 minutes in order to avoid postoperative complications. Sugihara et al. reported, thus strengthening the aforementioned condition, adverse events as a result of exceeding the 90-

minute intervention threshold.[10] Regarding the average duration of a single-use flexible ureteroscopy intervention, we mention the study by Mager et al. (2018), in which the results obtained as a result of 136 interventions (68 single-use and 68 by means of reusable ureteroscopy) were compared, where the average operating time was 76.8 minutes, a time value relatively close to that obtained in this study (duration already mentioned previously, more precisely 70.14 minutes).[11]

Regarding the therapeutic success rate (stone-free rate), defined as the lack of detection of fragments larger than 3 millimeters at 30 days post-operatively, at the CT examination, according to the data, a value of 54.6% could be observed following a single intervention. We note that this value is significant for a single procedure, taking into account the increased volume of treated lithiasis. At the same time, a number of 34 patients, representing a percentage of 45.4%, needed re-intervention, failing to achieve the desired "stone-free" after the first one. The second procedure resulted in a substantial increase in the therapeutic success rate, reaching 94.6%. Only 4 patients out of a total of 75 required 3 ureteroscopic interventions to achieve therapeutic success (an outstanding percentage of 5.4%). The presented results support the increased performance of the single-use flexible ureteroscopy procedure in the eventuality of a staged case approach. Moreover, we emphasize the fact that by using single-use instruments, it was possible to avoid complications with a high risk in the reprocessing of reusable instruments (an example being nosocomial infectious pathology), reducing costs to the same extent, indirectly, despite a higher initial price, per unit.

Thus, we can state that the results of the study under discussion, with a stone-free rate of 54.6% after a first intervention and one of 100% after three procedures, are in line with the specialized literature, strengthening the idea of the efficiency of single-use flexible ureteroscopy in the treatment of large kidney stones. A noteworthy example is that of Huang et al. (2020) who followed the evolution of 251 patients with kidney stones of 2 centimeters or more (an average of 2.7 centimeters) who underwent FURS treatment, over a period of 4 years. The results obtained by them showed a therapeutic success rate of 61.9% after only one intervention, 82.9% after a second procedure and almost 90% (89.5% to be exact) after the third. As a result of the data presented above, Huang et al. concluded by supporting the idea of safety and efficacy of single or staged FURS.

Giorgio Bozzini et al. (2021) also claims, in the study carried out by analyzing the data obtained as a result of the single-use intervention on 90 patients, the efficiency of the evaluated method, the stone-free rate reaching 90%, a value higher than the results of reusable ureteroscopy, where the author obtained a therapeutic success rate of approximately 86%.[12] A review by N F Davis et al. (2017), which followed the data obtained in 11 previous studies (totalling 466 patients), led to the assumption of a conclusion similar to those of the aforementioned studies, namely the confirmation of the effectiveness of single-use flexible ureteroscopy, with nothing inferior to the reusable variant, the therapeutic success rate recorded here being approximately 87%, in the conditions of a minor presence of post-procedural complications (approximately 9%).[13] Karagöz et al. (2020) obtained similar results, with a shift from a therapeutic success rate of 77% after a single intervention for the treatment of renal stones larger than 20 millimeters to 93% as a result of the staged approach to the therapeutic process.[14]

Fundamental in evaluating the safety and efficacy profile of single-use flexible ureteroscopy is also the incidence of post-procedural complications. In the studied group, 28% of the patients presented postoperative complications (a number of 21 people), while 72% of them (54 patients) did not experience such events. The results thus presented suggest a positive safety profile considering the size of the stones undergoing therapy. In the conducted study, the Clavier-Dindo classification was used. During the study, there were no Clavien grade 3 complications, which is another indicator of the technique's positive safety profile. The specialized literature presents results similar to the study carried out with incidences of complications in the scope of the one presented here. Thus, we mention the study carried out by H.Nour et al. (2024), where 103 patients with large renal lithiasis were treated by

single-use flexible ureteroscopy, the incidence of complications being 21%, most of them, like the study carried out, being minor.[15] R. Multescu et al. (2019) presented similar results, with a 21% incidence of adverse events occurring as a result of the treatment of 1000 consecutive cases of renal lithiasis, with a low severity in the majority of them.[16] The unitary differences may appear as a result of the variability of the lithiasic diameter (with an average of 27.5 millimeters in the studied group, compared to 25 millimeters in the study conducted by H.Nour et al.).[17] However, we bring back to the discussion the very low frequency of complications with high severity, a suggestive aspect regarding the safety of the analyzed method.

Conclusion

The results obtained following the evaluation of the patients studied encourage the extension of the indication of the analyzed technique to the treatment of large stones, especially considering the existing alternative, percutaneous nephrolithotomy, a method that involves a more significant morbidity. However, the therapeutic decision must remain a personalized one, with the integration of information related to the anatomy of the kidney, the size and location of the calculus and last but not least, the experience of the team involved.

References

1. Moftakhar L, Jafari F, Ghoddusi Johari M, Rezaeianzadeh R, Hosseini SV, Rezaianzadeh A. Prevalence and risk factors of kidney stone disease in population aged 40–70 years old in Kharameh cohort study: a cross-sectional population-based study in southern Iran. BMC Urol [Internet]. 2022;22(1):205. Available from: https://doi.org/10.1186/s12894-022-01161-x
2. Scales CD, Smith AC, Hanley JM, Saigal CS. Prevalence of Kidney Stones in the United States. Eur Urol. 2012 Jul 1;62(1):160–5.
3. Littlejohns TJ, Neal NL, Bradbury KE, Heers H, Allen NE, Turney BW. Fluid Intake and Dietary Factors and the Risk of Incident Kidney Stones in UK Biobank: A Population-based Prospective Cohort Study. Eur Urol Focus. 2020 Jul 15;6(4):752–61.
4. Sigurjonsdottir VK, Runolfsdottir HL, Indridason OS, Palsson R, Edvardsson VO. Impact of nephrolithiasis on kidney function. BMC Nephrol [Internet]. 2015;16(1):149. Available from: https://doi.org/10.1186/s12882-015-0126-1
5. Rule AD, Roger VL, Melton LJIII, Bergstralh EJ, Li X, Peyser PA, et al. Kidney Stones Associate with Increased Risk for Myocardial Infarction. Journal of the American Society of Nephrology [Internet]. 2010;21(10). Available from: https://journals.lww.com/jasn/fulltext/2010/10000/kidney_stones_associate_with_increased_risk_for.11.aspx
6. El-Husseiny T, Buchholz N. The role of open stone surgery. Vol. 10, Arab Journal of Urology. 2012. p. 284–8.
7. Alenezi H, Denstedt JD. Flexible ureteroscopy: Technological advancements, current indications and outcomes in the treatment of urolithiasis. Vol. 2, Asian Journal of Urology. Editorial Office of Asian Journal of Urology; 2015. p. 133–41.
8. Juliebø-Jones P, Ventimiglia E, Somani BK, Æsøy MS, Gjengstø P, Beisland C, et al. Single use flexible ureteroscopes: Current status and future directions. Vol. 4, BJUI Compass. John Wiley and Sons Inc; 2023. p. 613–21.
9. Partin A, Dmochowski R, Kavoussi L, Peters C. Campbell Walsh Wein UROLOGY. Philadelphia: ELSEVIER; 2020.
10. Geavlete P, Multescu R, Geavlete B. Influence of Pyelocaliceal Anatomy on the Success of Flexible Ureteroscopic Approach. J Endourol [Internet]. 2008 Oct 1;22(10):2235–40. Available from: https://doi.org/10.1089/end.2008.9719
11. Kachkoul R, Touimi GB, El Mouhri G, El Habbani R, Mohim M, Lahrichi A. Urolithiasis: History, epidemiology, aetiologic factors and management. Vol. 45, Malays J Pathol. 2023.
12. Dallera JE, Chandhoke PS. Epidemiology and Incidence of Stone Disease. In: Stoller ML, Meng M V, editors. Urinary Stone Disease: The Practical Guide to Medical and Surgical Management [Internet]. Totowa, NJ: Humana Press; 2007. p. 27–34. Available from: https://doi.org/10.1007/978-1-59259-972-1_2
13. Knoll T, Traxer O. Urolithiasis: Medical and surgical treatment. Eur Urol Focus. 2021 Jan 1;7(1):1–2.

14. Xuan H, Du Z, Xia L, Cao Y, Chen Q, Xue W. Comparison of outcomes between flexible ureteroscopy and mini-percutaneous nephrolithotomy in the management of upper calyceal calculi larger than 2 cm. BMC Urol. 2022 Dec 1;22(1).
15. Doddamani D, Sinha T, Talwar R. Efficacy of flexible fibreoptic ureteroscopy and Holmium laser in retrograde intrarenal surgery for calyceal calculi. Med J Armed Forces India [Internet]. 2011;67(3):217–20. Available from: https://www.sciencedirect.com/science/article/pii/S0377123711600440
16. Sorokin I, Mamoulakis C, Miyazawa K, Rodgers A, Talati J, Lotan Y. Epidemiology of stone disease across the world. World J Urol [Internet]. 2017;35(9):1301–20. Available from: https://doi.org/10.1007/s00345-017-2008-6
17. Chewcharat A, Thongprayoon C, Vaughan LE, Mehta RA, Schulte PJ, O'Connor HM, et al. Dietary Risk Factors for Incident and Recurrent Symptomatic Kidney Stones. Mayo Clin Proc [Internet]. 2022;97(8):1437–48. Available from: https://www.sciencedirect.com/science/article/pii/S0025619622002592
18. Shastri S, Patel J, Sambandam KK, Lederer ED. Kidney Stone Pathophysiology, Evaluation and Management: Core Curriculum 2023. Vol. 82, American Journal of Kidney Diseases. W.B. Saunders; 2023. p. 617–34.
19. Ratkalkar VN, Kleinman JG. Mechanisms of stone formation. Vol. 9, Clinical Reviews in Bone and Mineral Metabolism. 2011. p. 187–97.
20. El-Nahas AR, Shokeir AA, El-Assmy AM, Mohsen T, Shoma AM, Eraky I, et al. Post-percutaneous nephrolithotomy extensive hemorrhage: a study of risk factors. J Urol [Internet]. 2007;177(2):576–9. Available from: http://dx.doi.org/10.1016/j.juro.2006.09.048