Digital Flexible Ureteroscopy and Laser Lithotripsy for the Treatment of Large Renal Stones – A Literature Review

C. Cozma [1,2], P. Geavlete [1,2], D. Georgescu [1,2], B. Geavlete [1,2]

[1] "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
[2] Department of Urology, "St. John" Emergency Clinical Hospital, Bucharest, Romania

ABSTRACT

Introduction and Objectives. Flexible ureteroscopy (FURS) has become a feasible alternative for treating big renal stones as endoscopy and laser technology continues to advance and surgical experience grows. Numerous studies have shown that FURS treatment of big renal calculi is effective, with low complication rates and stone-free rates (SFR) that are equivalent to PCNL.

Materials and Methods. We performed a comprehensive search of the literature in July 2022, including relevant articles using the PubMed database to identify related publications concerning the flexible ureteroscopic treatment of renal stones over 2 cm in diameter. Review articles and original articles were included. Searches were limited to the English language and studies involving humans and adults.

Results. Regarding the primary efficacy outcome, all eight studies reported on SFRs and complications; Six studies reported on the average number of procedures performed, with four studies reporting on the average operative time. All studies reported on stone size. The combined data of the included studies showed that FURS had an average SFR of around 91.3% (81.8%–96%) with an average of 1.518 procedures per patient. The pooled data showed a 9.77% overall complication rate, with minor complications occurring in 49 (7.85%) patients, major complications in 12 (1.92%) patients, and a mortality rate of 0%. The average operation lasted 118.29 minutes. The total data showed a 2.66 cm average stone size.

Conclusion. FURS can successfully treat patients with stones larger than 2 cm with a high SFR and a low complication rate, even if PCNL is still the gold standard. Although this study has indicated that FURS is an effective alternative to PCNL, the results of observational cohort studies are from high-volume experienced facilities and may not be sufficient to change daily routine practice. A well-informed treatment choice should be made with the patients based on the results for FURS of the surgeons/centers because this high SFR might not be repeatable.

Key-words: flexible ureteroscopy, large renal stones, laser lithotripsy.

Correspondence to:
Dr. Cosmin Cozma M.D.
"Saint John" Emergency Clinical Hospital, Department of Urology
13 Vitan-Barzesti St., district 4, code 042122, Bucharest, Romania
Tel/Fax: +40213345970
e-mail: cozma_cosmin_91@yahoo.com

INTRODUCTION AND OBJECTIVES

With a lifetime frequency of 10% in people, renal stones are common. Obesity and diabetes raise the risk of renal stone disease globally by increasing the incidence in these patient populations. The most frequent reason for emergency admission to urology departments is flank pain from stones (renal colic). In approximately 35% of instances, stones form in the lower pole of the kidney, where they are least likely to pass naturally. Extracorporeal shockwave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and flexible ureterorenoscopy (FURS) with laser lithotripsy are the three current methods for removing lower pole kidney stones. [1]

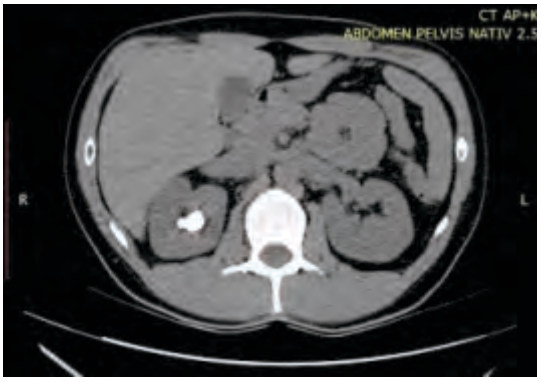


Image 1 : CT scan image of large pelvic stone

Flexible ureteroscopy (FURS) has become a feasible alternative for treating big renal stones as endoscopy and laser technology continues to advance and surgical experience grows. Numerous studies have shown that FURS treatment of big renal calculi is effective, with low complication rates and stone-free rates (SFR) that are equivalent to PCNL. Recently, they have been treated with similar success using flexible ureteroscopy and laser lithotripsy (FURS). A comparison study found that FURS required fewer second-stage procedures and was equally effective as PCNL for renal stones between 2 and 3 cm.

Reviewing the literature on renal stones larger than 2 cm treated with ureteroscopy and holmium laser lithotripsy was our goal. [2]

Renal calculi larger than 2 cm in diameter (Fig. 1 and Fig. 2) are still treated using percutaneous nephrolithotomy (PCNL). Despite the high clearance rate, PCNL is not without complications. Fever occurs in 10.8% of cases, transfusion occurs in 7%, thoracic complications occur in 1.5%, sepsis occurs in 0.5% of cases, organ injury occurs in 0.4% of cases, and embolization occurs in 0.4% of cases, and death occurs in 0.05% of cases. Even though the "mini-PCNL" has been used in recent years with smaller access tracts, problems are still common, and up to 2% of cases necessitate blood transfusions. PCNL is also restricted or contraindicated in patients with undesirable traits, such as those who are receiving long-term anticoagulant therapy, have morbid obesity, or have severe spinal abnormalities. [2]

Image 2 : CT scan reconstruction of large pelvic stone

MATERIALS AND METHODS

We performed a comprehensive search of the literature in July 2022, including relevant articles using the PubMed database. Review articles and original articles were included. Searches were limited to the English language and studies involving humans and adults. To identify related publications concerning the flexible ureteroscopic treatment of renal stones over 2 cm in diameter, the search terms 'flexible ureteroscopy' OR 'FURS' OR 'retrograde intrarenal surgery' OR 'RIRS' AND 'large renal stones' OR 'large renal calculi' OR 'renal stones over 2 cm' OR 'renal calculi over 2 cm' were included to attain relevant studies.
The following inclusion criteria were used to choose the final studies: language limited to English; renal stones were between 2-4 cm in diameter, and there

were no restrictions on the number or location of the stones. Additionally, the original comparative studies report at least one of the following outcomes for FURS: SFR, treatment session, operation time, overall complications, or Clavien grade complication. Studies that met any of the following exclusion criteria, however, were not included: (1) Including patients under the age of 18; and (2) Studies presented as conference presentations or abstracts.

RESULTS

The literature search turned up 296 papers, however, 273 of them were disregarded due to lack of relevance as determined by the titles (252) and abstracts (21). The papers' titles and abstracts did not specifically mention FURS or big stones, which is why they were excluded. In 23 research, complete papers were reviewed; eight of these studies were included in the review.

With no randomization or control groups, all of the included studies were cohort observational studies that reported on FURS for renal stones larger than 2 cm. Tables 1 and 2 show plots for all studies that were reported on the variables listed in the data extraction section. [2][3][4][5][7][8][10][11]

Table 1 : Patient demographics

Author	*Journal*	*Center (Country)*	*Year*	*Number of patients*	*Age*
Grasso A	J Urol	USA	1998	51	18-77
Scotland K	J Endourol	USA	2018	167	22-84
Karakoyunlu	Urolithiasis	Turkey	2015	60	Not mentioned
Huang J	Medicine (Baltimore)	USA	2020	251	22-80
Miernik A	World J Urol	Germany	2014	38	Not mentioned
Riley J	J Endourol	USA	2009	22	25-78
Breda A	J Urol	Spain	2008	15	Not mentioned
Takazawa R	Int J Urol	Japan	2012	20	Not mentioned

Author	Mean operative time	SFR after treatment completion	Mean number of procedures	Mean stone size (cm)	Minor complications	Major complications	Total complications
Grasso	Not mentioned	93%	1.3	2.4	0	3	3
Scotland	Not mentioned	94%	1.65	2.75	9	0	9
Karakoyunlu	114.46	96%	Not mentioned	Not mentioned	2	0	2
Huang	126.8±74.7	89.5%	1.4	2.65±0.7	27	6	33
Miernik	95	81.8%	Not mentioned	2.45	3	0	3
Riley	72 (28-138)	91%	1.82	3	3	2	5
Breda	Not mentioned	93.3%	2.3	2.2	3	0	3
Takazawa	Not mentioned	90%	1.4	3.1	2	1	3
Total	118.29	91.3%	1.518	2.66	49/624 (7.85%)	12/624 (1.92%)	9.77%

Table 2 : Review of the Literature for the treatment of large Renal Stones using Flexible Ureteroscopy and Laser Lithotripsy

The studies were published between 1998 and 2020, the research being conducted in Europe (3/8), the United States of America (4/8), and Asia (1/8). There were 624 patients with an age range between 18 and 84 years. All the studies reported on FURS of stones > 2cm.

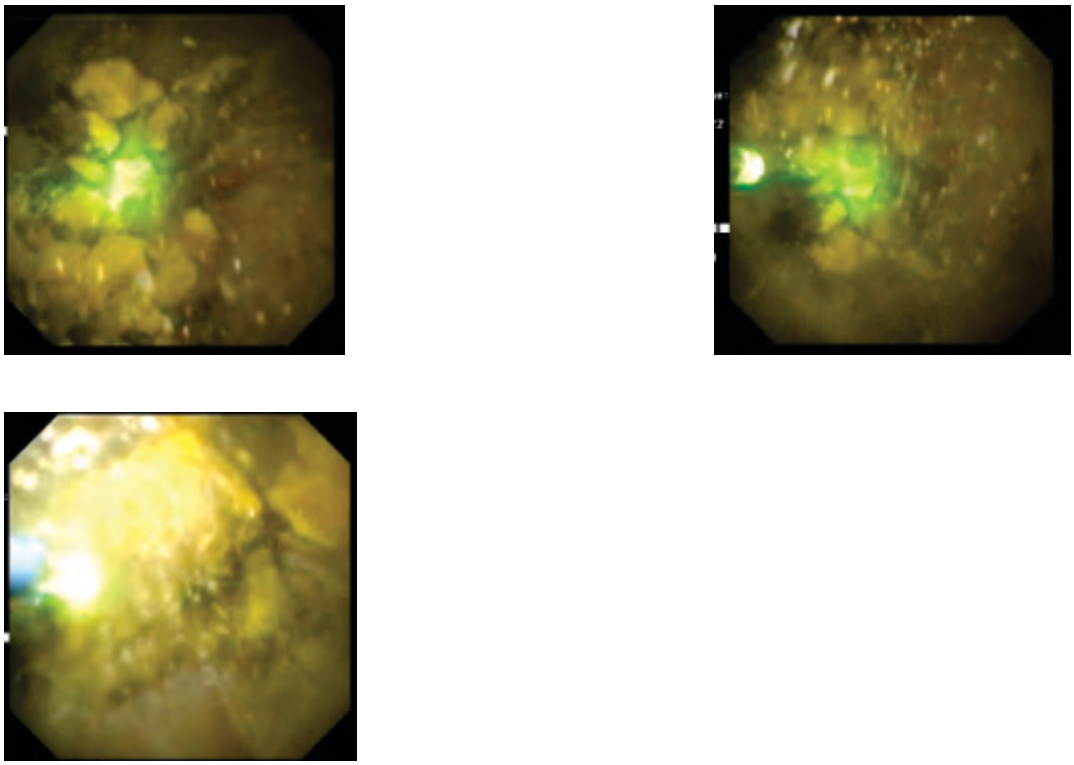
Regarding the primary efficacy outcome, all eight studies reported on SFRs and complications; Six studies reported on the average number of procedures performed, with four studies reporting on the average operative time. All studies reported on stone size.

The combined data of the included studies showed that FURS had an average SFR of around 91.3% (81.8%–96%) with an average of 1518 procedures per patient.

The pooled data showed a 9.77% overall complication rate, with minor complications occurring in 49 (7.85%) patients, major complications in 12 (1.92%) patients, and a

DISCUSSIONS

The techniques for fragmenting stones in the upper urinary system with a laser and ureteroscopy have been developed and improved (Fig. 3-5). For the treatment of proximal and distal ureteral stones, rigid ureteroscopy (URS) has been shown to be superior to SWL in terms of stone clearance.
With an average of 1.518 procedures per patient and a mean operating time of 118.29 minutes, FURS had an average SFR in this review of roughly 91.3% (81.8%-96%) for a mean stone size of 2.66 cm.



Images 3-5: Flexible ureteroscopy and Holmium laser lithotripsy of a large pelvic stone

According to Harmon and colleagues, their ureteroscope complication rates for URS decreased from 6.6% to 1.5% as a result of the smaller ureteroscope.[29] The overall complication rates have dropped due to advances in ureteroscopic technology, with major complications reported to be between 1% and 1.5%. At the same time, it has been reported that the overall complication rates in PCNL can reach 83%, with a major complication rate of 15% to 20%. For patients with obesity, anatomical deformities like kyphoscoliosis, and pregnancy, FURS has emerged as the preferred technique when other modalities have failed.
None of the research outlined what minor or major complications meant beforehand. For example, self-limiting hematuria or a urinary tract infection that required antibiotics or analgesics were considered minor complications.

Major complications, on the other hand, required additional procedures or close monitoring and were classified as grade II or above of the Clavien-Dindo classification, such as perforation, obstructive pyelonephritis, and steinstrasse syndrome.[15]

Advantages and disadvantages of the research
The main strength of the study continues to be the methodical strategy used to evaluate the last 24 years' worth of publications discussing patients who underwent FURS for large renal stones. Predetermined outcome parameters were used, and data were extracted using templates. Because they rely on and reflect the findings of the available primary studies, systematic reviews have the obvious problem of not always being able to offer precise advice on actions. Therefore, the inadequacies of the individual research are directly

related to the weaknesses of our conclusions. These nonrandomized studies could be significantly biased in how they chose their patients, evaluated their results, and reported them.

Limitations and potential future research topics

The fact that all the included studies were done retrospectively was one of this review's weaknesses. However, each study included a thorough explanation of the technique, which may be seen as reducing the possibility of bias. Despite these restrictions, the comparison parameters used in all the research were identical, allowing for a meta-analysis of the data to generate a more metaphorical conclusion and a subgroup analysis. All of the studies came from high-volume centers of excellence where endourologists with training and expertise performed the procedures. In places with less expertise, achieving such a high SFR might not be possible.

To assess the effectiveness of URS and laser fragmentation of big urinary stones, more study is necessary. Furthermore, for the treatment of stones larger than 2 cm, a multicentric randomized trial contrasting FURSL with PCNL is required. Ideally, the criteria should include operation timeframes, procedure counts per patient, hospital stays, visits to the emergency room or clinic, SFRs, and complication rates. These parameters must be defined explicitly. A cost analysis comparison of the two groups should also be done in addition. A recognized classification system, such as the Clavien-Dindo classification for surgical complications, should be used to group the complications.

CONCLUSIONS

FURS can successfully treat patients with stones larger than 2 cm with a high SFR and a low complication rate, even if PCNL is still the gold standard. Although this study has indicated that FURS is an effective alternative to PCNL, the results of observational cohort studies are from high-volume experienced facilities and may not be sufficient to change daily routine practice. A well-informed treatment choice should be made with the patients based on the results for FURS of the surgeons/centers because this high SFR might not be repeatable.

REFERENCES

1. McClinton, S., Starr, K., Thomas, R. et al. The clinical and cost effectiveness of surgical interventions for stones in the lower pole of the kidney: the percutaneous nephrolithotomy, flexible ureterorenoscopy and extracorporeal shockwave lithotripsy for lower pole kidney stones randomised controlled trial (PUrE RCT) protocol. Trials 21,(2020). https://doi.org/10.1186/s13063-020-04326-x
2. Huang JS, Xie J, Huang XJ, Yuan Q, Jiang HT, Xiao KF. Flexible ureteroscopy and laser lithotripsy for renal stones 2 cm or greater: A single institutional experience. Medicine (Baltimore). 2020 Oct 23;99(43):e22704. DOI: 10.1097/MD.0000000000022704.
3. Takazawa R, Kitayama S, Tsujii T. Successful outcome of flexible ureteroscopy with holmium laser lithotripsy for renal stones 2 cm or greater. Int J Urol. 2012 Mar;19(3):264-7. DOI: 10.1111/j.1442-2042.2011.02931.x. Epub 2011 Dec 6. PMID: 22145599.
4. Breda A, Ogunyemi O, Leppert JT, Lam JS, Schulam PG. Flexible ureteroscopy and laser lithotripsy for single intrarenal stones 2 cm or greater--is this the new frontier? J Urol. 2008 Mar;179(3):981-4. DOI: 10.1016/j.juro.2007.10.083. Epub 2008 Jan 22. PMID: 18207179.
5. Miernik A, Schoenthaler M, Wilhelm K, Wetterauer U, Zyczkowski M, Paradysz A, Bryniarski P. Combined semirigid and flexible ureterorenoscopy via a large ureteral access sheath for kidney stones >2 cm: a bicentric prospective assessment. World J Urol. 2014 Jun;32(3):697-702. DOI: 10.1007/s00345-013-1126-z. Epub 2013 Jul 3. PMID: 23821122.
6. Aboumarzouk OM, Monga M, Kata SG, Traxer O, Somani BK. Flexible ureteroscopy and laser lithotripsy for stones >2 cm: a systematic review and meta-analysis. J Endourol. 2012 Oct;26(10):1257-63. DOI: 10.1089/end.2012.0217. Epub 2012 Jul 30. PMID: 22642568.
7. Karakoyunlu N, Goktug G, Şener NC, Zengin K, Nalbant I, Ozturk U, Ozok U, Imamoglu A. A comparison of standard PCNL and staged retrograde FURS in pelvis stones over 2 cm in diameter: a prospective randomized study. Urolithiasis. 2015 Jun;43(3):283-7. DOI: 10.1007/s00240-015-0768-2. Epub 2015 Apr 3. PMID: 25838180.

8. Scotland KB, Rudnick B, Healy KA, Hubosky SG, Bagley DH. Retrograde Ureteroscopic Management of Large Renal Calculi: A Single Institutional Experience and Concise Literature Review. J Endourol. 2018 Jul;32(7):603-607. DOI: 10.1089/end.2018.0069
9. Al-Qahtani SM, Gil-Deiz-de-Medina S., Traxer O. Predictors of clinical outcomes of flexible ureterorenoscopy with holmium laser for renal stone greater than 2 cm. Adv Urol. 2012. 2012543537.4.
10. Riley JM, Stearman L, Troxel S. Retrograde ureteroscopy for renal stones larger than 2.5 cm. J Endourol. 2009. 231395-1398.6.
11. Grasso M, Conlin M, Bagley D. Retrograde ureteropyeloscopic treatment of 2 cm or greater upper urinary tract and minor Staghorn calculi. J Urol. 1998. 160346-351.
12. Hyams ES, Munver R, Bird VG et al. Flexible ureterorenoscopy and holmium laser lithotripsy for the management of renal stone burdens that measure 2 to 3 cm: A multi-institutional experience. J Endourol. 2010. 241583-1588.
13. EAU Guidelines. Edn. presented at the EAU Annual Congress Amsterdam, 2022. ISBN 978-94-92671-16-5.
14. Galvin DJ, Pearle MS. The contemporary management of renal and ureteric calculi. BJU Int. 2006. 981283-1288.
15. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004. 240205-213.27.
16. Kourambas J, Byrne RR, Preminger GM. Does a ureteral access sheath facilitate ureteroscopy? J Urol. 2001. 165789-793.28.