Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

# Reduced renal function and Clavien-Dindo grade II or higher complications after percutaneous nephrolithotomy: a retrospective cohort study

**Mario Gerardo Tomás Navarro**

drgnavarro.uro@gmail.com

Mexican Social Security Institute

**Edgar Beltrán Suárez**

Mexican Social Security Institute

**Félix Santaella Torres**

Mexican Social Security Institute

**Research Article**

**Keywords:** percutaneous nephrolithotomy, chronic kidney disease, postoperative complications, Clavien-Dindo, kidney calculi

**Posted Date:** November 13th, 2026

**DOI:** https://doi.org/10.21203/rs.3.rs-11462950/v1

**License:** This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

**Additional Declarations:** No competing interests reported.

# Abstract

We evaluated whether reduced preoperative renal function is associated with Clavien-Dindo grade II or higher complications in patients undergoing percutaneous nephrolithotomy (PCNL). Observational, analytical, retrospective cohort study including 295 patients who underwent PCNL for stone disease between January 2020 and December 2025 at a Mexican referral center. The exposure was preoperative renal function (eGFR ≥ 60 vs < 60 mL/min/1.73 m², the latter defining chronic kidney disease [CKD]); the primary outcome was Clavien-Dindo ≥ II complications according to the CROES classification. Bivariate analysis and binary logistic regression adjusted for ASA class, Guy's Stone Score, and solitary kidney were performed, with significance set at $p < 0.05$. Mean age was 49.8 ± 13.1 years and 59.0% were women. CKD was present in 21.4% (n = 63). The overall rate of Clavien ≥ II complications was 14.9%. No association was found between CKD and Clavien ≥ II complications in either crude (OR 1.07; 95% CI 0.48–2.35; p = 0.874) or adjusted analysis (OR 1.03; 95% CI 0.43–2.45; p = 0.947). CKD patients had a higher prevalence of solitary kidney (OR 14.2) and more complex stones, with no difference in surgical success (Zero Fragments 69.8% vs 65.5%; p = 0.519). Reduced renal function was not associated with an increased risk of Clavien ≥ II complications after PCNL. The procedure can be performed safely in patients with CKD when adequate perioperative protocols are applied.


# Introduction

Nephrolithiasis is among the most common benign urological conditions worldwide, with a reported lifetime risk of 5–10% and point prevalences of 10–13% in middle- and high-income countries [1, 2]. In Mexico, population data from Yucatán describe a prevalence near 5.5%, above the national average, attributed to water hardness and family history [3]. Chronic kidney disease (CKD) has become a major public health problem in Mexico, with an estimated prevalence around 9% and type 2 diabetes as the leading cause [4]. Nephrolithiasis and CKD share cardiometabolic risk factors such as obesity, hypertension, type 2 diabetes, and metabolic syndrome, and stone disease is independently associated with components of the metabolic syndrome, particularly abdominal obesity and insulin resistance [5, 6]. Because referral centers concentrate complex stone disease in patients with accumulated metabolic comorbidity, a substantial proportion of patients presenting for stone surgery already have some degree of reduced renal function, diagnosed or otherwise, especially when lithiasis is recurrent [7, 8].

Percutaneous nephrolithotomy (PCNL) is the treatment of choice for stones larger than 2 cm, partial or complete staghorn calculi, and multiple intrarenal stones [9, 10, 11, 12]. Technical refinements such as miniaturized tracts (mini-, ultramini-, and micro-PCNL) have sought to reduce parenchymal damage, bleeding, and postoperative pain while maintaining comparable clearance in small and medium stones [16, 17]. The Clinical Research Office of the Endourological Society (CROES) global study reported stone-free rates near 76% with a single procedure and an overall complication rate of 15%, with a predominance of low-grade events [13, 22]. The Clavien-Dindo classification [28], adapted and validated for PCNL by CROES, has become the standard for reporting morbidity, and even grade I-II events have been shown to prolong hospital stay and increase costs [14, 15, 23].

Reduced renal function is a recognized state of systemic vulnerability associated with anemia, uremic bleeding diathesis, immune dysfunction, chronic low-grade inflammation, and altered drug pharmacokinetics, all of which could plausibly increase perioperative morbidity [18, 19, 20]. Several cohorts suggest that PCNL is feasible and generally safe in patients with CKD, with neutral or favorable effects on glomerular filtration rate when patient selection and comorbidity control are adequate [13, 21]. However, evidence on the specific association between CKD and postoperative complications remains heterogeneous. We therefore evaluated whether reduced preoperative renal function is associated with Clavien-Dindo grade II or higher complications after PCNL in a Mexican referral center.

## Materials and methods

**Study design and population.** We conducted an observational, analytical, retrospective cohort study in the Urology Department of the Hospital de Especialidades "Dr. Antonio Fraga Mouret," Centro Médico Nacional La Raza (IMSS), Mexico City. The cohort was assembled consecutively (census sampling) from all adult patients who underwent PCNL for stone disease between January 1, 2020 and December 31, 2025.

The primary exposure was preoperative renal function, classified by KDIGO categories as preserved (eGFR > = 60 mL/min/1.73 m²) or reduced (eGFR < 60 mL/min/1.73 m², defining CKD) [18, 19]. The primary outcome was the presence of at least one Clavien-Dindo grade > = II complication during hospitalization, categorized with the CROES system adapted for PCNL [23].

Inclusion required age > = 18 years, a diagnosis of renal lithiasis treated by PCNL, preoperative serum creatinine obtained 24–48 h before surgery with data sufficient to calculate eGFR, and complete clinical records to classify postoperative complications. We excluded percutaneous procedures for non-stone indications, major combined procedures in which complications could not be reasonably attributed to the percutaneous procedure, and patients with established severe sepsis or septic shock before surgery. Records with incomplete data for the exposure or primary outcome were removed.

**Surgical technique and perioperative management.** Procedures followed a standardized institutional protocol. The percutaneous access tract calibre was recorded for each case, as tract diameter is a recognized determinant of the extent of parenchymal injury and perioperative bleeding. Antibiotic prophylaxis was guided by the preoperative urine culture when available, with antimicrobial selection directed by the isolated organism and its susceptibility; when a urine culture was not available, empirical prophylaxis with ceftriaxone was administered. Microbiological profiling of urine cultures was not an objective of this study and was not analyzed as a variable.

**Sample size.** Assuming complication proportions of 0.12 with preserved function and 0.30 with reduced function, alpha 0.05 and 80% power, approximately 79 subjects per group (158 total) were required. Census inclusion yielded 295 patients, exceeding the minimum.

**Statistical analysis.** Normality was assessed with the Shapiro-Wilk test. Continuous variables are reported as mean ± SD or median (IQR) as appropriate, and categorical variables as frequencies and percentages. Surgical success was defined by the Zero Fragments criterion (residual = 0 mm) assessed on non-contrast CT performed 3–4 months after the procedure. Stone complexity was graded with the Guy's Stone Score [29] and the S.T.O.N.E. nephrolithometry score [33], and estimated blood loss was derived with the Nadler and Gross formulas [30, 31]. Bivariate comparisons used Student t or Mann-Whitney U for continuous variables and chi-square or Fisher exact tests for categorical variables, with crude odds ratios (OR) and 95% confidence intervals (CI). The primary analysis was a binary logistic regression model with Clavien > = II as the dependent variable and CKD as the main independent variable, adjusted for confounders identified in bivariate analysis: ASA class, Guy's Stone Score, and solitary kidney. Ordinal ASA and Guy's Stone Score were dichotomized (ASA III vs I-II; Guy III-IV vs I-II) to preserve at least 10 events per variable (44 events available for a maximum of 4 covariates). Model performance was assessed with McFadden and Nagelkerke pseudo-$R^2$, Akaike information criterion, and area under the ROC curve (AUC). Significance was set at $p < 0.05$. Analyses used Jamovi 2.6 (R 4.4). The study was approved by the institutional ethics committee and conducted according to STROBE recommendations for observational studies (STROBE checklist provided as Supplementary Material).

# Results

**Cohort characteristics.** Among 295 patients, mean age was 49.8 ± 13.1 years and 174 (59.0%) were women. Median body mass index was 28.0 kg/m² (IQR 25.4–31.4). Arterial hypertension was the most frequent comorbidity (30.2%), followed by hydronephrosis (23.7%), diabetes (18.0%), and solitary kidney (10.8%). Predominant anesthetic risk was ASA II (53.6%). Median preoperative serum creatinine was 0.90 mg/dL (IQR 0.76–1.10) and median eGFR 87.0 mL/min/1.73 m² (IQR 69.0-100.5). By KDIGO category, 232 patients (78.6%) had preserved renal function and 63 (21.4%) had CKD. Median stone burden was 563.2 mm² (IQR 314.0-1022.9); 66.5% of patients were Guy's Stone Score III-IV, confirming a cohort of considerable technical complexity (Table 1).

**Stone and surgical characteristics.** The supine position was used in 95.6% of cases and a single percutaneous access in 86.8% (two tracts 12.2%, three tracts 1.0%), most frequently through the lower calyx (66.8%). Pneumatic lithotripsy was most common (74.6%). The most frequent main-tract calibre was 26 Fr (50.5%), followed by 24 Fr (18.0%) and 18 Fr (15.3%), reflecting a predominance of standard-calibre PCNL (full tract calibre data in Supplementary Table S2a). Median operative time was 128 min (IQR 90–175) and median calculated blood loss (Nadler and Gross formulas) 319 mL (IQR 175–554) [30, 31]; transfusion was required in 15 patients (5.1%). Under the Zero Fragments criterion, 196 patients (66.4%) achieved surgical success (Table 2).

**Postoperative complications.** Overall, 225 patients (76.3%) had no complications. The rate of significant complications (Clavien > = II, the primary outcome) was 14.9% (n = 44). The most frequent grade > = II events were blood transfusion (3.7%), fever requiring antibiotics (3.7%), pelvic perforation requiring double-J stent (1.4%), bleeding requiring angioembolization or nephrectomy (1.4%), and sepsis (1.0%).

No grade IVb or V events occurred (Table 3). This distribution, dominated by transfusion and infection-related events, is consistent with the complication pattern reported in large PCNL series and reviews classified by the modified Clavien system [24, 25, 26].

**CKD versus non-CKD comparison.** Patients with CKD were older (median 53 vs 49 years; p = 0.046) and had lower BMI (27.1 vs 28.4 kg/m²; p = 0.002). Solitary kidney was markedly more frequent in the CKD group (36.5% vs 3.9%; OR 14.2; 95% CI 6.15-33.0; p < 0.001) and was the strongest association with CKD. Stone complexity was greater in CKD patients, with higher proportions of Guy's Stone Score III-IV (85.7% vs 61.2%; p = 0.002) and high STONE Score [33] (58.7% vs 34.5%; p = 0.001), and greater stone burden (779 vs 537 mm²; p = 0.038). No significant differences were observed in surgical variables (laterality, position, number of tracts, lithotripsy type, diversion, operative or fluoroscopy time, calculated blood loss; all p > 0.05). The Zero Fragments rate was similar between groups (69.8% CKD vs 65.5% non-CKD; p = 0.519). For the primary outcome, the complication rate was nearly identical: 14.3% in CKD versus 15.1% in non-CKD patients (crude OR 1.07; 95% CI 0.48–2.35; p = 0.874) (Table 4).

**Multivariable analysis.** In the crude model, CKD was not associated with Clavien > = II complications (OR 0.94; 95% CI 0.43–2.07; p = 0.874). After adjustment for ASA, Guy's Stone Score, and solitary kidney, the association remained non-significant (adjusted OR 1.03; 95% CI 0.43–2.45; p = 0.947). The proximity between crude and adjusted estimates indicates no substantial confounding. No covariate reached significance; Guy's Stone Score III-IV showed a non-significant trend toward higher risk (OR 1.73; 95% CI 0.82–3.63; p = 0.150). Model discrimination was marginal (AUC 0.574; Nagelkerke R² 0.019) (Table 5).

# Discussion

In this cohort of 295 patients undergoing PCNL, CKD was not associated with Clavien-Dindo > = II complications in either bivariate (crude OR 1.07; p = 0.874) or adjusted analysis (OR 1.03; p = 0.947). Our interpretation is that the low burden of significant complications, and the preservation of renal outcomes, reflect the consistent application of standardized pre-, peri-, and intraoperative protocols rather than the absence of risk in this population. Contrary to our initial hypothesis, reduced renal function did not translate into measurable excess morbidity.

The overall Clavien > = II rate (14.9%) is consistent with the literature. The CROES PCNL global study reported an overall complication rate of 15% in 5,803 patients, with a predominance of low-grade events (Clavien 0 in 79.5%), closely comparable to the 14.9% significant-complication rate in our cohort despite our higher proportion of complex stones (Guy III-IV in 66.5%) [13, 22]. The predominance of low-grade complications is also concordant with series applying the modified Clavien system to PCNL morbidity [24, 25]. Published results on the CKD-complication association are heterogeneous: some report that preoperative renal dysfunction increases complications and renal deterioration, while others, like ours, show that with adequate patient selection, preoperative optimization, strict infection control, and minimally invasive technique, PCNL can be performed safely in CKD patients without significant differences in major complications [21, 22]. The minimal change between crude (0.94) and adjusted

(1.03) OR indicates that ASA, Guy's Stone Score, and solitary kidney introduced no appreciable confounding.

There are plausible pathophysiological reasons to expect that reduced renal function might predispose to low- and intermediate-grade complications, including impaired sodium and water handling, uremic bleeding diathesis, reduced immunity with chronic inflammation, altered drug metabolism, and frequent cardio-renal-metabolic multimorbidity, all of which have been associated with greater postoperative morbidity and mortality in patients with CKD [20, 27]. That our data did not reproduce this expected gradient supports the view that a standardized perioperative pathway can offset these mechanisms.

Regarding surgical success, contemporary literature has migrated from the traditional stone-free rate, which accepts residual fragments < = 3–4 mm [34, 35], toward the stricter Zero Fragments criterion (residual = 0 mm), because even small fragments can cause symptomatic events, recurrent infection, obstruction, and new stone growth [32]. Under this standard, our success rate of 66.4% is comparable or superior to classic stone-free rates in cohorts of similar complexity; in the trial by Ulvik et al., Zero Fragments rates for renal stones were 33% with Holmium:YAG and 66% with Thulium Fiber Laser [32].

CKD patients showed a distinctive clinical profile: older age, lower BMI, markedly higher prevalence of solitary kidney (36.5% vs 3.9%), and more complex, voluminous stones, consistent with the pathophysiology by which metabolic alterations favor larger, recurrent stones [8]. The strong association with solitary kidney (OR 14.2) likely reflects lower renal reserve and prior contralateral nephrectomy, and warrants particular clinical attention.

This study has strengths: a robust cohort exceeding the calculated sample size, the PCNL-specific CROES classification, an adjusted analysis respecting the 10-events-per-variable rule, the stricter Zero Fragments criterion, and validated categorization protocols (KDIGO, ASA, Guy's and STONE scores). Limitations include the retrospective single-center design; the limited number of Clavien > = II events (n = 44), which gives 80% power only for OR > = 2.5, so weaker effects could be undetected, although the wide CI (0.43–2.45) makes a clinically relevant effect unlikely; the absence of medium- and long-term renal function follow-up; the marginal model discrimination (AUC 0.574) reflecting unmeasured factors; and reliance on clinical records for complication grading.

# Conclusions

In this cohort of 295 patients undergoing PCNL, reduced renal function was not associated with Clavien-Dindo >=II complications in either bivariate or adjusted analysis. In our view, the low rate of significant complications and the preservation of renal function are explained by the consistent application of adequate pre-, peri-, and intraoperative protocols rather than by an absence of underlying risk. Although CKD patients showed a distinctive clinical profile, these characteristics did not translate into significantly higher postoperative complication rates, and the similar Zero Fragments rate supports that CKD does not compromise procedural success. Reduced renal function should not be considered a

contraindication to PCNL. Prospective multicenter studies with larger event numbers and long-term follow-up are needed to confirm these findings.

## Declarations

**Funding.** No funding was received for conducting this study.

**Competing interests.** The authors have no competing interests to declare that are relevant to the content of this article.

**Ethics approval.** This retrospective chart review study involving human participants was performed in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. The protocol was approved by the Research Ethics Committee No. 35018 (22 January 2026) and by the Local Health Research Committee No. 3501 (30 January 2026) of the Hospital de Especialidades “Dr. Antonio Fraga Mouret,” Centro Médico Nacional La Raza, IMSS (institutional registration number R-2026-3501-015; COFEPRIS 17 CI 09 002 047; CONBIOETICA 09 CEI 033 2017121).

**Consent to participate.** Formal informed consent was waived by the institutional ethics committee because the study was classified as “without risk” under Article 17 of the Regulations of the General Health Law on Health Research (RLGSMIS), being a review of clinical records and databases with preservation of data confidentiality and participant privacy.

**Consent to publish.** Not applicable. The manuscript contains no individually identifiable patient information, images, or videos.

**Author contributions.** Conceptualization: M.G.N.T., E.B.S. Methodology: M.G.N.T., E.B.S. Formal analysis and investigation: M.G.N.T. Data curation: M.G.N.T. Writing - original draft preparation: M.G.N.T. Writing - review and editing: E.B.S., F.S.T. Supervision: E.B.S., F.S.T. All authors read and approved the final manuscript.

**Data availability.** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to institutional restrictions and patient privacy protections under Mexican health data regulations.

## References

1. Ortegón-Gallareta R et al (2019) Epidemiologic profile of hospitalizations due to urolithiasis in Yucatán, México. Rev Mex Urol 79(5):1–8
2. Awedew AF, Wang L, Reiner RC, Hay SI, Vos T, Murray CJL et al (2024) The global, regional, and national burden of urolithiasis in 204 countries and territories, 2000–2021: a systematic analysis for

the Global Burden of Disease Study 2021. EClinicalMedicine 78:102924. https://doi.org/10.1016/j.eclinm.2024.102924

3. Medina-Escobedo M, Zaidi M, Real-de León E, Orozco-Rivadeneyra S (2002) Urolithiasis prevalence and risk factors in Yucatán, México. Salud Publica Mex 44(6):541–545
4. Argaiz ER et al (2023) La carga de enfermedad renal crónica en México. Análisis de los años de vida ajustados por discapacidad. Gac Med Mex 159(6):501–512
5. Medina-Escobedo M, Alcocer-Dzul R, López-López J, Villanueva-Jorge S (2015) Obesity as a risk factor for metabolic disorders in adults with urolithiasis. Rev Med Inst Mex Seguro Soc 53(6):692–697
6. López-Leal J, Cueto-Manzano AM, Martínez-Torres J et al (2017) Prevalencia de enfermedad renal crónica y factores de riesgo en el programa de atención DiabetIMSS. Rev Med Inst Mex Seguro Soc 55(Supl 2):S210–S218
7. Reyna-Sevilla A, Duque-Molina C, Quezada-Sánchez C, Avilés-Hernández R, Torres-Toledano M (2022) Comportamiento y patrones de demanda de consultas por afección renal en el IMSS, 2011–2020. Rev Med Inst Mex Seguro Soc 60(6):606–615
8. Medina-Escobedo M et al (2022) Recurrence of nephrolithiasis and surgical events are associated with chronic kidney disease in adult patients. Med (Kaunas) 58(3):420. https://doi.org/10.3390/medicina58030420
9. Park S (2007) Percutaneous nephrolithotomy. In: Smith AD, Badlani GH, Bagley DH et al (eds) Smith's Textbook of Endourology, 2nd edn. Humana, Totowa, NJ, pp 505–520
10. Patel SR, Nakada SY (2015) The modern history and evolution of percutaneous nephrolithotomy. J Endourol 29(2):153–157
11. European Association of Urology (2024) EAU Guidelines on Urolithiasis 2024. EAU Guidelines Office, Arnhem
12. Zeng G, Zeng T, Pearle M et al (2022) European Association of Urology Section of Urolithiasis (EULIS) review on percutaneous nephrolithotomy. Curr Opin Urol 32(2):113–120
13. Bilen CY, Inci K, Kocak B, Tan B, Sarikaya S, Sahin A (2008) Impact of percutaneous nephrolithotomy on estimated glomerular filtration rate in patients with chronic kidney disease. J Endourol 22(5):895–900
14. Clavien PA, Barkun J, de Oliveira ML et al (2009) The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 250(2):187–196
15. López-Maguey R, Rojas-Cruz CY, Sánchez-García R et al (2017) Percutaneous nephrolithotomy complications according to the Clavien-Dindo classification. Actas Urol Esp 41(9):604–610
16. Zeid M, Sayedin H, Sridharan N, Narayanaswamy A, Abul F, Jacob PT, Giri S, Sarica K, Almousawi S (2022) Super-mini percutaneous nephrolithotomy for nephrolithiasis: a systematic review and meta-analysis. Cureus 14(12):e32253. https://doi.org/10.7759/cureus.32253

17. Thakur A, Sharma AP, Devana SK, Parmar KM, Mavuduru RS, Bora GS, Mandal AK (2021) Does miniaturization actually decrease bleeding following percutaneous nephrolithotomy? A single center randomized trial. J Endourol 35(10):1449–1456. https://doi.org/10.1089/end.2020.0533
18. Levey AS, Coresh J, Balk E et al (2005) Definition and classification of chronic kidney disease: a position statement from Kidney Disease: Improving Global Outcomes (KDIGO). Kidney Int 67(6):2089–2100
19. Levin A, Stevens PE (2014) Summary of KDIGO 2012 CKD guideline: behind the scenes, need for guidance, and a framework for moving forward. Kidney Int 85(1):49–61. https://doi.org/10.1038/ki.2013.444
20. Mathew A, Devereaux PJ, O'Hare A et al (2008) Chronic kidney disease and postoperative mortality: a systematic review and meta-analysis. Kidney Int 73(9):1069–1081
21. Izol V, Deger M, Akdogan N et al (2021) The effect of percutaneous nephrolithotomy on the estimated glomerular filtration rate in patients with chronic kidney disease. J Endourol 35(5):583–588
22. de la Rosette JJM, Assimos D, Desai M et al (2011) The Clinical Research Office of the Endourological Society percutaneous nephrolithotomy global study: indications, complications, and outcomes in 5803 patients. J Endourol 25(1):11–17
23. de la Rosette JJMCH, Opondo D, Daels FPJ et al (2012) Categorisation of complications and validation of the Clavien score for percutaneous nephrolithotomy. Eur Urol 62(2):246–255
24. Shin TS, Cho HJ, Hong SH et al (2011) Complications of percutaneous nephrolithotomy classified by the modified Clavien grading system: a single-center experience. Korean J Urol 52(11):769–775
25. Tefekli A, Karadag MA, Tepeler A et al (2008) Classification of percutaneous nephrolithotomy complications using the modified Clavien grading system: looking for a standard. Eur Urol 53(1):184–190
26. Escobar Monroy R, Proietti S, De Leonardis F, Gisone S, Scalia R, Mongelli L, Gaboardi F, Giusti G (2025) Complications in Percutaneous Nephrolithotomy. Complications 2(1):5. https://doi.org/10.3390/complications2010005
27. Liao CC, Liu CC, Lee YW et al (2024) Complications and mortality after surgery in patients with chronic kidney disease: a retrospective cohort study based on a multicenter clinical database. J Multidiscip Healthc 17:3535–3544
28. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240(2):205–213
29. Thomas K, Smith NC, Hegarty N, Glass JM (2011) The Guy's stone score - grading the complexity of percutaneous nephrolithotomy procedures. Urology 78(2):277–281
30. Nadler SB, Hidalgo JH, Bloch T (1962) Prediction of blood volume in normal human adults. Surgery 51(2):224–232
31. Gross JB (1983) Estimating allowable blood loss: corrected for dilution. Anesthesiology 58(3):277–280

32. Ulvik Ø, Æsøy MS, Juliebø-Jones P, Gjengstø P, Beisland C (2022) Thulium fibre laser versus holmium:YAG for ureteroscopic lithotripsy: outcomes from a prospective randomised clinical trial. Eur Urol 82(1):73–79
33. Okhunov Z, Friedlander JI, George AK, Duty BD, Moreira DM, Srinivasan AK et al (2013) S.T.O.N.E. nephrolithometry: novel surgical classification system for kidney calculi. Urology 81(6):1154–1159
34. Ghani KR, Wolf JS Jr (2015) What is the stone-free rate following flexible ureteroscopy for kidney stones? Nat Rev Urol 12(5):281–288
35. Somani BK, Desai M, Traxer O, Lahme S (2014) Stone-free rate (SFR): a new proposal for defining levels of SFR. Urolithiasis 42:95. https://doi.org/10.1007/s00240-013-0630-3

# Tables

**Table 1** Clinical and demographic characteristics of the cohort (n = 295)

| Characteristic | Value |
|---|---|
| Age (years), mean ± SD | 49.8 ± 13.1 |
| Female sex, n (%) | 174 (59.0) |
| BMI (kg/m²), median (IQR) | 28.0 (25.4–31.4) |
| Arterial hypertension, n (%) | 89 (30.2) |
| Diabetes mellitus, n (%) | 53 (18.0) |
| Solitary kidney, n (%) | 32 (10.8) |
| ASA II, n (%) | 158 (53.6) |
| Serum creatinine (mg/dL), median (IQR) | 0.90 (0.76–1.10) |
| eGFR (mL/min/1.73 m²), median (IQR) | 87.0 (69.0–100.5) |
| Preserved renal function (eGFR ≥60), n (%) | 232 (78.6) |
| Chronic kidney disease (eGFR <60), n (%) | 63 (21.4) |
| Stone burden (mm²), median (IQR) | 563.2 (314.0–1022.9) |
| Guy's Stone Score III–IV, n (%) | 196 (66.5) |

*BMI body mass index, ASA American Society of Anesthesiologists, eGFR estimated glomerular filtration rate, IQR interquartile range, SD standard deviation*

**Table 3** Postoperative complications according to the CROES Clavien-Dindo system (n = 295)

| Complication | n (%) |
|---|---|
| No complication (grade 0) | 225 (76.3) |
| Grade I | 26 (8.8) |
| Grade II | 27 (9.2) |
| Grade IIIa | 5 (1.7) |
| Grade IIIb | 5 (1.7) |
| Grade IVa | 7 (2.4) |
| Significant complication (Clavien ≥II) | 44 (14.9) |
| Blood transfusion | 11 (3.7) |
| Fever requiring antibiotics | 11 (3.7) |
| Pelvic perforation with double-J stent | 4 (1.4) |
| Bleeding with angioembolization/nephrectomy | 4 (1.4) |
| Sepsis | 3 (1.0) |

*CROES Clinical Research Office of the Endourological Society. No grade IVb or V events occurred. The primary outcome was Clavien ≥II.*

*Tables 2 (stone and surgical characteristics), 2a (percutaneous tract calibre), 3 (full list of postoperative complications), 4 (CKD vs non-CKD comparison), and 5 (logistic regression) are provided as Supplementary Material (Online Resource 1).*

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- UrolithiasisSupplementaryMaterial.docx