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Impact of Postoperative Silodosin on Delayed Stone-Free Status After Retrograde Intrarenal Surgery: Emphasis on Patients with Residual Fragments

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Abstract

Purpose: Residual fragments after retrograde intrarenal surgery (RIRS) may compromise delayed stone-free (SF) status and increase the likelihood of secondary intervention. This study evaluated the association between postoperative silodosin and short-term SF outcomes after RIRS, with particular emphasis on patients with residual fragments.

Methods: This comparative cohort study included 141 adults who underwent RIRS between November 2024 and November 2025. Patients were grouped according to postoperative silodosin 8 mg use (silodosin, n=70; no silodosin, n=71). SF status was defined strictly as no visible stone on non-contrast computed tomography at 4 and 8 weeks. Univariable and multivariable logistic regression analyses were performed, and a predefined subgroup analysis was conducted among patients who were not SF at the end of surgery.

Results: In the overall cohort, 4-week SF rates did not differ significantly between groups (48.6% vs. 36.6%, p=0.152), whereas 8-week SF status was higher with silodosin (65.7% vs. 49.3%; OR 1.97, 95% CI 1.00-3.88, p=0.049). Among patients with residual fragments, silodosin was associated with higher 4-week SF status (17.9% vs. 0%, p=0.020) and 8-week SF status (32.1% vs. 3.4%; OR 13.26, 95% CI 1.55-113.47, p=0.018). In adjusted models, silodosin was not an independent predictor, whereas stone size, multiplicity, and Hounsfield unit were more consistent determinants.

Conclusion: Postoperative silodosin was associated with improved delayed stone clearance after RIRS, particularly in patients with residual fragments. Larger prospective studies are needed to clarify its role before second-look intervention.

Introduction

Retrograde intrarenal surgery (RIRS) is an established minimally invasive treatment for renal stones because of its broad applicability, favorable safety profile, and continuous technological refinement [1]. However, procedural success after RIRS is not determined solely by intraoperative fragmentation. The clinically relevant endpoint is postoperative stone-free (SF) status, which may evolve as residual fragments pass or persist during follow-up. This distinction is increasingly important because current guideline and consensus documents emphasize standardized outcome reporting and appropriate postoperative assessment after RIRS [2].

SF outcomes after RIRS are multifactorial. Larger stone burden, multiple stones, unfavorable lower-pole anatomy, and greater stone complexity reduce the likelihood of complete clearance [3]. Nephrolithometric tools such as the R.I.R.S. score have been developed to predict SF status [4], although stone size, density, multiplicity, and intrarenal anatomy remain central determinants of postoperative clearance [5].

Residual fragments are a major reason why intraoperative clearance does not always translate into true postoperative SF status. Recent evidence has shown substantial heterogeneity in residual-fragment definitions and confirms that computed tomography (CT) is the most reliable modality for detecting fragments after RIRS [6]. This is clinically relevant because even small fragments may persist, regrow, or cause later stone-related events.

Adjunctive medical therapy aimed at facilitating fragment passage after RIRS therefore warrants further study. Although alpha-blockers are established agents in medical expulsive therapy for ureteral stones, silodosin studies in endourology have mainly evaluated preoperative or perioperative use, particularly for ureteral access sheath insertion, ureteral compliance, and instrumentation-related ureteral trauma [7, 8]. Evidence addressing postoperative silodosin for passage of intrarenal residual fragments remains limited [9].

This study evaluated the association between postoperative silodosin use and short-term SF outcomes after RIRS in a tertiary referral cohort. We compared 4-week and 8-week SF rates between patients who did and did not receive silodosin, identified predictors of postoperative SF status, and performed a subgroup analysis in patients with residual fragments at the end of surgery.

Methods

Study design and patient selection

This comparative cohort study included adult patients aged 18–65 years who underwent RIRS at a tertiary referral center between November 2024 and November 2025. All procedures were performed using the same brand of single-use flexible ureterorenoscope. Consecutive eligible patients were classified according to postoperative silodosin use, defined as oral silodosin 8 mg once daily initiated on the day of surgery and continued for 2 months; adherence was defined as completion of the prescribed 2-month treatment course without discontinuation or documented interruption. The final study population included 141 patients: 71 in the no-silodosin group and 70 in the silodosin group (Fig. 1).

Patients were excluded if they were pregnant or had a solitary kidney, renal failure, prior open stone surgery, medullary sponge kidney, or pelvic-ureteric junction obstruction. Patients who discontinued silodosin during follow-up or did not complete the 8-week follow-up were also excluded.

The study was conducted in accordance with the Declaration of Helsinki. Institutional ethics committee approval was obtained before study initiation (Basaksehir Cam and Sakura City Hospital Ethics Committee, approval no. 2024-44). All patients had negative preoperative urine cultures and received prophylactic antibiotics before surgery.

Surgical technique

Procedures were performed in lithotomy position under general or spinal anesthesia. An 8/9.5 Fr semi-rigid ureteroscope was initially used for passive ureteral dilatation and ureteral assessment. A Zebra nitinol guidewire (0.032/0.035 inch; Boston Scientific, USA) was advanced into the pelvicalyceal system, followed by monorail advancement of a 7.5 Fr single-use flexible ureterorenoscope.

In prestented patients, a ureteral access sheath was inserted over the guidewire before flexible ureterorenoscope advancement. Stone fragmentation was performed with a Holmium:YAG laser using a 200-mum laser fiber and settings of 0.5–0.8 J and 15–30 Hz. A dusting strategy was routinely preferred to minimize basket extraction.

After lithotripsy, the pelvicalyceal system was visually inspected for residual fragments and fluoroscopy was used to reduce the risk of overlooking substantial residual fragments. A 4.8 Fr, 26 cm double-J stent was placed in all patients. A Foley catheter was left for approximately 6–12 hours, and uncomplicated cases were discharged on the postoperative day with oral antibiotics.

Postoperative management and follow-up

All patients underwent follow-up at 4 and 8 weeks. SF status at both time points was assessed by non-contrast CT with 3 mm cuts. Double-J stents were removed under local anesthesia at postoperative week 4. No included patient required additional postoperative surgical intervention during follow-up, including intervention for steinstrasse, symptomatic residual fragments, or stent-related complications after stent removal.

Variables and outcome definitions

Collected variables included age, body mass index, Charlson comorbidity index, stone size, Hounsfield unit, infundibulopelvic angle, renal infundibular length (RIL), R.I.R.S. score, sex, prior stone history, multiple stones, lower calyceal stone involvement, hydronephrosis grade, preoperative stenting, preoperative nephrostomy, ureteral access sheath use, operative time, hospital stay, complications, and intraoperative SF status. Stone location distribution was reported as supplementary data.

RIL was defined as the distance from the most distal point of the bottom stone-containing calyx to the midpoint of the lip of the renal pelvis. The R.I.R.S. score was based on renal stone density, inferior pole stone location, renal infundibulopelvic angle, RIL, and stone burden [4]. The primary outcomes were 4-week and 8-week SF rates. SF status was defined as absence of any visible residual stone on non-contrast CT. Intraoperative SF status was defined as absence of visible unfragmented stone at the end of surgery.

Statistical analysis

Continuous variables were summarized as median and interquartile range, and categorical variables as number and percentage. Baseline comparisons used the Mann-Whitney U test for continuous variables, Fisher's exact test for sparse categorical variables, and the chi-square test where appropriate.

Univariable logistic regression was performed to identify predictors of 8-week SF status. Clinically relevant covariates included age, body mass index, Charlson comorbidity index, stone size, Hounsfield unit, infundibulopelvic angle, RIL, R.I.R.S. score, operative time, prior stone history, multiple stones, lower calyceal stone presence, hydronephrosis grade, preoperative stenting, preoperative nephrostomy, and ureteral access sheath use. The final multivariable models for 4-week and 8-week SF status included postoperative silodosin, stone size, R.I.R.S. score, multiple stones, operative time, and Hounsfield unit. Effect estimates were reported as odds ratios (ORs) with 95% confidence intervals (CIs). In the residual-fragment subgroup, Fisher's exact test was used when complete separation prevented OR estimation. A two-sided p value < 0.05 was considered statistically significant.

Results

A total of 141 patients were analyzed. The no-silodosin and silodosin groups were generally comparable for age, body mass index, Charlson comorbidity index, stone density, infundibulopelvic angle, RIL, R.I.R.S. score, sex, previous stone history, stone multiplicity, lower calyceal stone presence, hydronephrosis, preoperative stenting, preoperative nephrostomy, ureteral access sheath use, complications, hospital stay, and intraoperative SF status. However, patients in the silodosin group had smaller stones (median 14.0 mm [IQR 10.0–20.0] vs. 18.0 mm [IQR 13.0–25.0], p = 0.026) and shorter operative times (70.0 min [IQR 55.0–90.0] vs. 80.0 min [IQR 60.0-100.0], p = 0.011) (Table 1).

Table 1
Baseline characteristics according to postoperative silodosin use

Variable	No Silodosin (n = 71)	Silodosin (n = 70)	p-value
Age (years)	50.0 (38.0–61.0)	45.0 (34.0–56.0)	0.090†
BMI (kg/m²)	29.0 (26.0–32.0)	27.9 (25.0–31.0)	0.234†
Charlson comorbidity index	1.0 (0.0–2.0)	0.0 (0.0–1.0)	0.088†
Stone size (mm)	18.0 (13.0–25.0)	14.0 (10.0–20.0)	**0.026**†
Hounsfield Unit	1100 (900–1300)	1050 (880–1250)	0.343†
Infundibulopelvic angle (°)	45.0 (35.0–60.0)	47.0 (35.0–60.0)	0.321†
RIL (mm)	25.0 (20.0–30.0)	24.0 (20.0–30.0)	0.383†
R.I.R.S. score	7.0 (5.0–8.0)	6.0 (5.0–8.0)	0.152†
Operation time (min)	80.0 (60.0–100.0)	70.0 (55.0–90.0)	**0.011**†
Hospital stay (days)	1.0 (1.0–2.0)	1.0 (1.0–2.0)	0.610†
Gender (male)	43 (60.6%)	48 (68.6%)	0.380*
Stone history (yes)	43 (60.6%)	34 (48.6%)	0.178*
Multiple stones	31 (43.7%)	22 (31.4%)	0.165*
Lower calyx stone (yes)	27 (38.0%)	27 (38.6%)	1.000*
Hydronephrosis (grade ≥ 2)	18 (25.3%)	15 (21.4%)	0.147‡
Preop Stent (yes)	19 (26.8%)	22 (31.4%)	0.582*
Preop nephrostomy (yes)	3 (4.2%)	3 (4.3%)	1.000*
Ureteral Acsess Sheat (yes)	66 (93.0%)	66 (94.3%)	1.000*
Clavien–Dindo complications (≥ grade 2)	6 (8.5%)	2 (2.9%)	0.112‡
Stone-free at surgery	42 (59.2%)	42 (60.0%)	1.000*

RIL: the distance from most distal point at bottom stone-containing calix to midpoint of lip of renal pelvis. RIRS score: Renal stone density, Inferior pole stone, Renal Infundibulopelvic angle, RIL, Stone burden.

*:Fisher's exact test †: Mann-Whitney U test ‡: Chi-square

Variable	No Silodosin (n = 71)	Silodosin (n = 70)	p-value
Stone-free at 4 weeks	26 (36.6%)	34 (48.6%)	0.175*
Stone-free at 8 weeks	35 (49.3%)	46 (65.7%)	0.061*
RIL: the distance from most distal point at bottom stone-containing calix to midpoint of lip of renal pelvis. RIRS score: Renal stone density, Inferior pole stone, Renal Infundibulopelvic angle, RIL, Stone burden.			
*:Fisher's exact test †: Mann-Whitney U test ‡: Chi-square			

Renal pelvis stones were the most common location in both groups (40.8% without silodosin and 40.0% with silodosin). Isolated lower calyx stones were more frequent in the silodosin group (28.6% vs. 7.0%), whereas combined lower calyx and pelvis stones were more frequent in the no-silodosin group (21.1% vs. 4.3%). Stone location data were presented descriptively as supplementary information.

In univariable logistic regression for 8-week SF status, postoperative silodosin was associated with higher odds of SF status (OR 1.97, 95% CI 1.00-3.88, p = 0.049). Larger stone size (OR 0.87, 95% CI 0.82–0.93, p < 0.001), higher Hounsfield unit (OR 0.999, 95% CI 0.998-1.000, p = 0.018), higher R.I.R.S. score (OR 0.61, 95% CI 0.45–0.82, p = 0.001), longer operative time (OR 0.97, 95% CI 0.95–0.98, p < 0.001), and multiple stones (OR 0.27, 95% CI 0.13–0.55, p < 0.001) were inversely associated with 8-week SF status (Table 2).

Table 2
Univariable logistic regression analysis for predictors of 8-week stone-free status

Variable	OR	95% CI	p-value
Postop silodosin	**1.97**	1.00–3.88	**0.049**
Age	0.98	0.96–1.01	0.150
BMI	1.05	0.97–1.13	0.197
Charlson index	0.88	0.70–1.10	0.267
Stone size (mm)	**0.87**	0.82–0.93	**< 0.001**
Hounsfield Unit	0.999	0.998–1.000	**0.018**
Infundibulopelvic angle	1.00	0.98–1.02	0.739
RIL	1.00	0.96–1.04	0.831
R.I.R.S. score	**0.61**	0.45–0.82	**0.001**
Operation time (min)	**0.97**	0.95–0.98	**< 0.001**
Stone history	0.61	0.31–1.20	0.149
Multiple stones	**0.27**	0.13–0.55	**< 0.001**
Lower calyx stone	0.61	0.31–1.21	0.160
Hydronephrosis grade	0.82	0.58–1.17	0.271
Preop Stent	0.61	0.29–1.27	0.184
Preop nephrostomy	0.57	0.15–2.23	0.420
Ureteral Acsess Sheat	1.75	0.45–6.82	0.420

RIL: the distance from most distal point at bottom stone-containing calix to midpoint of lip of renal pelvis. RIRS score: Renal stone density, Inferior pole stone, Renal Infundibulopelvic angle, RIL, Stone burden.

In multivariable analysis for 8-week SF status, postoperative silodosin was no longer independently associated with the outcome (adjusted OR 1.39, 95% CI 0.64–3.01, p = 0.406). Stone size (adjusted OR 0.88, 95% CI 0.81–0.96, p = 0.003), multiple stones (adjusted OR 0.39, 95% CI 0.16–0.94, p = 0.035), and Hounsfield unit (adjusted OR 0.998, 95% CI 0.997–0.9999, p = 0.039) remained significant (Table 3). In the 4-week model, silodosin was not an independent predictor (adjusted OR 1.13, 95% CI 0.53–2.41, p = 0.747), whereas stone size remained significant (adjusted OR 0.91, 95% CI 0.84–0.99, p = 0.033) (Table 4).

Table 3
Multivariable logistic regression analysis for predictors of 8-week stone-free status

Variable	Adjusted OR	95% CI	p-value
Postoperative silodosin	1.39	0.64–3.01	0.406
Stone size (mm)	**0.88**	0.81–0.96	**0.003**
R.I.R.S. score	1.17	0.76–1.80	0.464
Multiple stones	**0.39**	0.16–0.94	**0.035**
Operation time (min)	1.00	0.98–1.02	0.679
Hounsfield Unit	**0.998**	0.997–0.9999	**0.039**

RIL: the distance from most distal point at bottom stone-containing calix to midpoint of lip of renal pelvis. RIRS score: Renal stone density, Inferior pole stone, Renal Infundibulopelvic angle, RIL, Stone burden.

Table 4
Multivariable logistic regression analysis for 4-week stone-free status

Variable	Adjusted OR	95% CI	p-value
Postoperative silodosin	1.13	0.53–2.41	0.747
Stone size (mm)	**0.91**	0.84–0.99	**0.033**
R.I.R.S. score	1.19	0.80–1.78	0.405
Multiple stones	0.43	0.18–1.02	0.055
Operation time (min)	0.98	0.97–1.00	0.129
Hounsfield Unit	0.999	0.998–1.000	0.153

RIL: the distance from most distal point at bottom stone-containing calix to midpoint of lip of renal pelvis. RIRS score: Renal stone density, Inferior pole stone, Renal Infundibulopelvic angle, RIL, Stone burden.

Direct comparison showed no significant difference in 4-week SF status in the overall cohort (26/71 [36.6%] without silodosin vs. 34/70 [48.6%] with silodosin; OR 1.64, 95% CI 0.83–3.20, p = 0.152). At 8 weeks, SF status was higher in the silodosin group (46/70 [65.7%] vs. 35/71 [49.3%]; OR 1.97, 95% CI 1.00-3.88, p = 0.049) (Table 5).

Table 5
Comparison of stone-free rates according to silodosin use in the overall cohort and residual stone subgroup

Analysis Group	Outcome	No Silodosin	Silodosin	OR (95% CI)	p-value
Overall cohort (n = 141)	4-week SFR	26/71 (36.6%)	34/70 (48.6%)	1.64 (0.83–3.20)	0.152
	8-week SFR	35/71 (49.3%)	46/70 (65.7%)	1.97 (1.00–3.88)	0.049
Residual stone subgroup (n = 57)	4-week SFR	0/29 (0.0%)	5/28 (17.9%)	—*	0.020†
	8-week SFR	1/29 (3.4%)	9/28 (32.1%)	13.26 (1.55–113.47)	0.018

-SFR: Stone Free Rate

* In the 4th-week residual subgroup, the odds ratio (OR) could not be calculated because there were no events in the control group (complete separation). †p-value Fisher's exact test ile hesaplandı

Among patients with residual stones at the end of surgery (n = 57), 4-week SF status occurred in 0/29 patients (0.0%) without silodosin and 5/28 patients (17.9%) with silodosin (p = 0.020). At 8 weeks, SF status was achieved in 1/29 patients (3.4%) without silodosin and 9/28 patients (32.1%) with silodosin (OR 13.26, 95% CI 1.55-113.47, p = 0.018) (Table 5, Fig. 2).

Discussion

The main finding of this study was that postoperative silodosin was associated with improved delayed stone clearance after RIRS, particularly among patients who were not SF at the end of surgery. In the overall cohort, the unadjusted difference became significant at 8 weeks but not at 4 weeks. In the residual-fragment subgroup, the effect was more pronounced, with 8-week SF status increasing from 3.4% without silodosin to 32.1% with silodosin, although the confidence interval was wide.

This subgroup signal is clinically relevant because patients leaving the operating room with residual fragments are those most likely to enter the management window between observation, interval imaging, and possible second-look intervention. Prior studies have linked residual fragments after ureteroscopy and RIRS to repeat surgery, stone-related events, and uncertainty regarding optimal management [6, 9, 10]. The current literature has focused mainly on predicting residual fragments, defining their natural history, and improving intraoperative clearance. Direct evidence on postoperative alpha-blocker therapy for patients already known to be non-SF after RIRS is limited.

The surrounding alpha-blocker literature supports this distinction. Most silodosin studies have evaluated preoperative or perioperative administration to facilitate ureteral access sheath insertion or reduce access-related ureteral injury, rather than delayed intrarenal fragment passage [7, 8]. Earlier adjuvant alpha-blocker studies after ureteroscopic lithotripsy were broader and not centered on a deliberately

defined residual-fragment population [11]. Therefore, the present findings suggest that postoperative silodosin may be more appropriately studied as a focused bridging strategy for initially non-SF patients than as a routine medication for all RIRS patients.

The adjusted analyses are important for interpretation. Postoperative silodosin did not remain an independent predictor of 4-week or 8-week SF status, whereas stone burden-related variables such as stone size, multiplicity, and Hounsfield unit showed more consistent associations. This indicates that the mechanical characteristics of stone disease remain the main determinants of postoperative clearance. Nevertheless, the residual-fragment subgroup result suggests that a low-burden medical strategy may assist delayed passage in selected patients and could reduce the number proceeding to repeat intervention if confirmed prospectively [12].

Several limitations should be acknowledged. First, this was a non-randomized, single-center cohort, and treatment allocation according to postoperative silodosin use introduces selection bias and residual confounding despite multivariable adjustment. Second, the residual-fragment subgroup was relatively small, producing wide confidence intervals and limiting precision. Third, although CT-based follow-up and a stringent SF definition strengthen outcome assessment, the findings do not establish that silodosin can replace or safely defer second-look intervention. Future randomized studies focused on initially non-SF patients are needed to identify which residual-fragment profiles benefit and whether reintervention rates can be reduced.

Conclusion

Postoperative silodosin use after RIRS was associated with improved delayed stone clearance, with the most notable effect observed in patients with residual fragments. Although silodosin did not remain an independent predictor after adjustment for stone-related factors, the subgroup finding highlights a potentially underexplored management window between the index procedure and repeat surgery. Larger prospective studies are required to define the role of postoperative silodosin in structured residual-fragment management after RIRS.

Declarations

Funding

The authors received no specific funding for this study.

Competing interests

The authors declare that they have no competing interests.

Ethics approval

This study was approved by the Basaksehir Cam and Sakura City Hospital Ethics Committee in accordance with the Declaration of Helsinki (approval no. 2024-44).

Consent to participate

The requirement for informed consent was waived by the Institutional Review Board because of the retrospective nature of the study.

Consent for publication

Not applicable.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

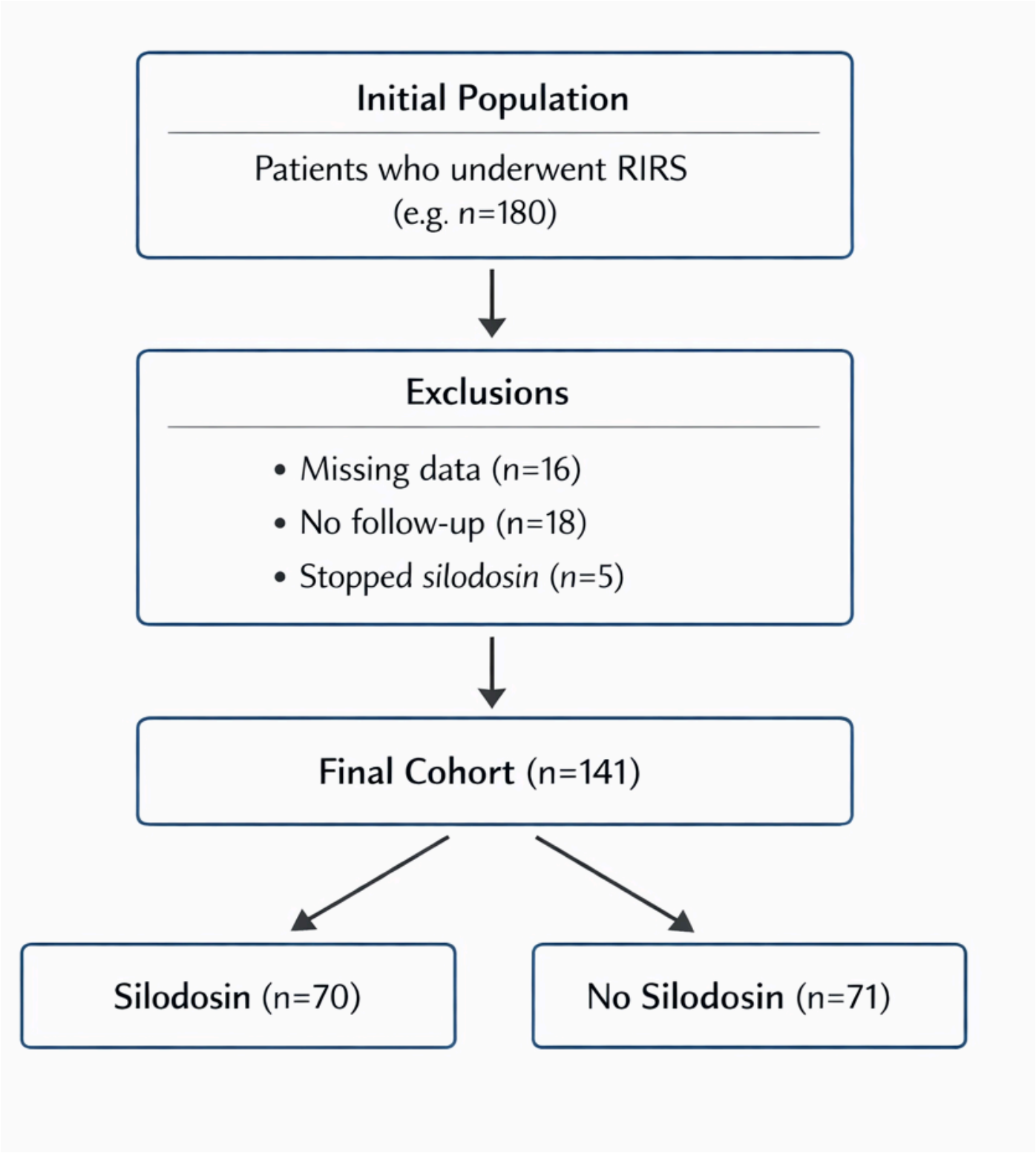


Figure 1

Flowchart of the study population

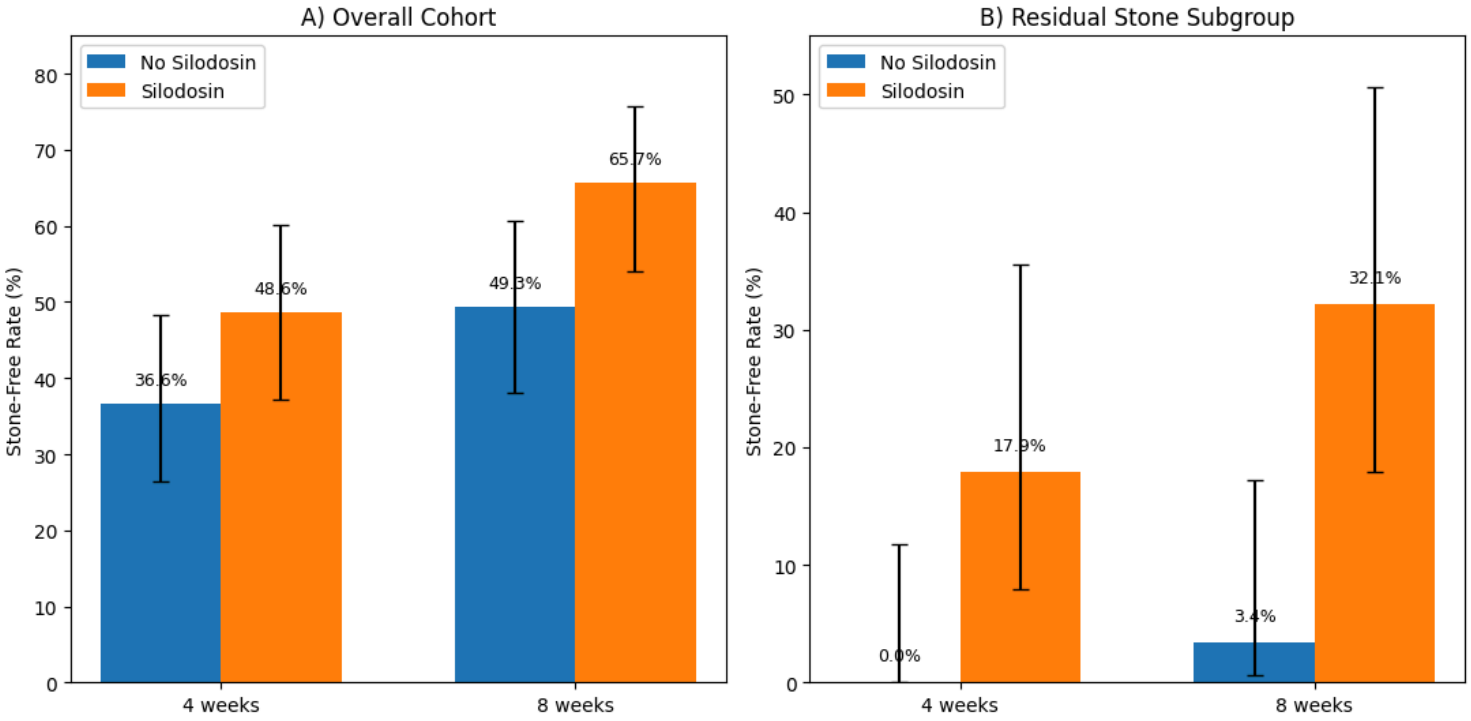


Figure 2

Overall cohort (a) and residual stone subgroup (b) stone-free rate comparisons

Supplementary Files

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- SupplementaryTable.docx