



# The role of preoperative ureteral stenting in retrograde intrarenal surgery in renal stone patients: a propensity score-matched study

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**Contributions:** (I) Conception and design: All authors; (II) Administrative support: None; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: DY Cho; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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**Background:** The purpose of this study was to investigate the effect of preoperative ureteral stenting on retrograde intrarenal surgery (RIRS).

**Methods:** We retrospectively analyzed RIRS cases from October 2014 to June 2017. Patients were divided into two groups according to preoperative ureteral stent insertion. The characteristics of the patients [age, body mass index (BMI), sex, previous disease history, hemoglobin, creatinine, estimated glomerular filtration rate (eGFR)], characters of stone (size, number, density, location), ureteral access sheath (UAS) success rate, perioperative complication, operative time, hospitalization time, period with stent, postoperative urinary tract infection (UTI) rate, stone free rate (SFR), and additional treatment rate were analyzed.

**Results:** RIRS was performed for 122 patients. Seventy-three patients had preoperative ureteral stents before RIRS, while 49 patients did not have preoperative ureteral stents. The median size of the stone was 14.5 mm. Overall SFR was 87.7%. Preoperative eGFR was relatively high in patients who underwent preoperative stenting (68.18 vs. 79.01 mL/min/1.73 m<sup>2</sup>, P=0.042). Preoperative stenting led to improvement in the success rate of UAS insertion (97.3% vs. 87.8%, P=0.038) during surgery. Before and after propensity score matching revealed a significant difference in operation time when the diameter of the stone was smaller than 1 cm (P=0.019 and P=0.004). However, there was no significant difference in operation time, postoperative UTI rate, additional treatment rate, or SFR.

**Conclusions:** Preoperative ureteral stenting can facilitate UAS insertion, and reduce operation time in RIRS for stones with a diameter less than 1 cm.

**Keywords:** Kidney; renal stone; retrograde intrarenal renal surgery; stent; ureter

Submitted Nov 13, 2019. Accepted for publication Feb 14, 2020.

doi: 10.21037/tau.2020.03.09

**View this article at:** <http://dx.doi.org/10.21037/tau.2020.03.09>

## Introduction

Retrograde intrarenal surgery (RIRS) is one of the treatments considered primarily for kidney stone with diameter less than 2 cm (1). Ureteral access sheath (UAS) is an essential and commonly used tool for RIRS (2). The benefit of the use of UAS in RIRS has been proven in various studies. UAS is advantageous as it facilitates repeated intra-ureteral insertion of the flexible ureteroscope and allows irrigation fluid to be increased while maintaining

low pressure in the kidneys, thus facilitating perfusion and vision during endoscopic surgery (3-5).

However, sometimes the sheath does not fit well, causing difficulty in operation. For ureter with a very small diameter, UAS insertion might not be possible. It has been reported that up to 10% of patients are unable to insert UAS because of the diameter of a small ureter or a small orifice, because of their small ureteral diameter (6). To avoid failure, a variety of methods have been used to enable UAS insertion

when performing RIRS (6). One such method is a manual dilation of the ureter via pre-operative stent insertion and the method is considered as effective and safe (7). However, as the operation is performed in two stages, there exist possibilities of increase in patient's discomfort and cost of surgery (6). Several studies have reported that preoperative ureteral stenting affects the outcome of ureteroscopic stone surgery (8-10). Some authors have also argued that the preoperative ureteral stent can extend the ureter passively (7). However, none of the studies has reported the relationship between preoperative ureteral stenting and success rate of accessed sheath insertion. Therefore, the objective of this study was to investigate the relationship between preoperative ureteral stenting and UAS insertion and analyze the effect of renal stone surgery on outcome.

## Methods

The study was approved by the Institutional Review Board of Inje University Sanggye Paik Hospital (approval code: H-2018-10-003). This was a retrospective study and exempted from patient written consent. All contents and protocols related to this study followed the Helsinki guidelines. The primary endpoint was the stone free rates (SFRs) between the ureter and preoperative groups. And the secondary endpoint was related to the operation duration, complication rates, access sheath insertion success rates, and clinical SFRs (less than 4 mm). The inclusion criteria were those age 18 or older who underwent RIRS surgery with renal stones October 2014–June 2017. Only those cases wherein UAS was performed during the RIRS surgery were included. Some patients had delayed RIRS surgery after the ureteral stent was inserted because the ureteroscopic lithotripsy (URS) was not inserted. Some patients had a pre-stenting plan before surgery. Some patients have had surgery for renal stones after the ureteral stent was inserted for a variety of reasons, including pain, acute kidney injury, infection, and hydronephrosis. Medical records of 122 patients who underwent RIRS with renal stone from October 2014 to June 2017 in a single institutional hospital were retrospectively analyzed. Patients who underwent previous stone surgery, such as RIRS, URS, percutaneous nephrolithotomy (PCNL), minimally invasive PCNL, or laparoscopic ureterolithotomy were excluded. Patients who underwent ureter surgery such as pyeloplasty and those who had ureteral stricture, were also excluded. Eligible patients were divided into prestented group and

non-stented group. Preoperative ureteral stent insertion was performed under local anesthesia. First, retrograde pyelography using cystoscopy and the open-ended 5-Fr ureteral catheter was performed and the ureteral stent was inserted using hydrophilic and stiff guide wire. The size of the ureteral stent inserted before surgery was 6–7 Fr. The preoperative ureteral stent indwelling period was 1–2 weeks. RIRS was usually performed about 1–2 weeks subsequent to stent insertion. All patients, except those with urine culture positive, generally administered third-generation cephalosporin (ceftriaxone 2 g) one hour before surgery. In the case of symptomatic systemic infection or urine culture positive, antibiotics were used for 1–2 weeks. After confirming that the culture was negative, surgery was performed. All patients underwent surgery under general anesthesia. UAS insertion was attempted prior to the flexible ureteroscopy procedure. A flexible ureteroscope was inserted under a hydrophilic guide wire for patients with narrow ureter and in whom UAS insertion was a failure. The size of the UAS was mostly 12/14 Fr. In some cases, it was 10/12 Fr or 11/13 Fr. UAS insertion routinely tries 12/14 Fr UAS first. If the 12/14 Fr UAS does not fit, try the 11/13 Fr and 10/12 Fr with smaller inner diameters. The average length was 45 cm for men and 35 cm for women. Stone fragmentation was performed using holmium: yttrium-aluminum-garnet (Holmium YAG) laser. Removal of the stone was done using a stone basket to the maximal extent possible. Dusting was performed on the remaining residual stone. Ureter injury was confirmed by examining the inside of the ureter when removing the UAS, accompanied with the flexible URS, and removing the UAS and descending from the renal pelvis to the distal ureter. If there were no postoperative complications such as a ureter injury, the postoperative ureter stent was removed one week after the operation routinely. SFR was defined as the diameter of the residual stones on CT, 0 and <4 mm. CT was generally performed three months after RIRS.

The characteristics of the patients [age, body mass index (BMI), sex, previous disease, hemoglobin, creatinine (Cr), estimated glomerular filtration rate (eGFR)], characters of stone (location, size, number, density, laterality), success rate of UAS insertion, intraoperative complication, operative time, hospitalization time, period with ureteral stent, postoperative urinary tract infection (UTI) rate, SFR, and additional treatment rate were analyzed. The difference in operation time according to stone size was also analyzed.

In statistical analysis, continuous variables were expressed as median value and range or mean values and standard

deviation using technical statistics. Nominal variables are expressed as a probability (%) through frequency analysis and crossover analysis. The primary endpoint was SFR analyzed based on two criteria: the complete free rate of 0 mm and a clinical free rate of less than 4 mm. The secondary endpoint was the difference in operation time and success rate of access sheath insertion according to the use of a preoperative ureteral stent. One-to-one propensity score-matched analysis was performed. The propensity score was calculated by preoperative covariates using multivariate regression analysis for each patient. Covariates were age, BMI, sex, Cr level, eGFR, hydronephrosis, and stone characteristics. All statistical tests were performed using IBM SPSS Statistics, version 22.0 (IBM, Armonk, NY, USA) and a P value of less than 0.05 was considered statistically significant.

## Results

A total of 122 patients were investigated. The non-stented group comprised of 49 patients and the pre-stented group comprised of 73 patients. The mean age of the patients was  $54.6 \pm 14.6$  years in the non-stented group and  $56.7 \pm 14.0$  years in the pre-stented group. There were no significant differences in age ( $P=0.440$ ), gender ( $P=0.579$ ), diabetes mellitus ( $P=0.914$ ), hypertension ( $P=0.239$ ), cardiovascular disease ( $P=0.707$ ), cerebrovascular event ( $P=0.348$ ), preoperative Cr level ( $P=0.966$ ), or preoperative hemoglobin level ( $P=0.570$ ) between the two groups. However, the value of eGFR in the non-stented group was significantly lower compared with the pre-stented group ( $68.18 \pm 32.87$  vs.  $79.01 \pm 25.12$ ,  $P=0.042$ ). In the pre-stented group, mean Cr level was 1.4 mg/dL and mean eGFR was  $55.31 \text{ mL/min/1.73 m}^2$  at the time of preoperative ureteral stent indwelling. There were no significant differences in stone characteristics such as laterality ( $P=0.461$ ), density ( $P=0.262$ ), size ( $P=0.662$ ), number ( $P=0.206$ ), or accompanied hydronephrosis ( $P=0.424$ ) between the two groups (Table 1).

Intraoperative ureter injury and bleeding were not associated with preoperative ureteral stent indwelling ( $P=0.151$ ). There were 4 (5.5%) intraoperative complications in the pre-stented group, including one intrarenal bleeding, three ureteral injury. For the intrarenal bleeding case, intraoperative transfusion was performed. However, no additional procedures such as embolization were required. Postoperative UTI occurred in 3 (6.1%) cases in the non-stented group and in six cases (8.2%) in the pre-stented

group ( $P=0.664$ ). As all eight cases of postoperative UTI showed abnormal urine test and more than 38 degrees of fever, they were treated with antibiotics. One case was sepsis requiring intensive care unit treatment. There was no significant difference in intraoperative ureter injury and bleeding ( $P=0.151$  and  $0.411$ ), postoperative UTI ( $P=0.664$ ), SFR ( $P=0.700$ ), clinically SFR <4 mm ( $P=0.827$ ), operative time ( $P=0.664$ ), additional treatment ( $P=0.991$ ), hospitalization period ( $P=0.678$ ), or postoperative period with stent ( $P=0.471$ ) between the two groups. There was no significant difference in intraoperative and postoperative complications between the two groups after propensity score matching (Table 2). However, a significant difference in the success rate of UAS insertion according to the presence of preoperative ureter stent insertion was observed. The success rate of UAS insertion was achieved in 87.8% in the non-stented group and 97.3% in the pre-stented group ( $P=0.038$ ). The success rate of UAS insertion was also significantly different between the two groups after propensity score matching ( $P=0.035$ ) (Table 2). The perioperative complications were not significantly different between the two groups (Table 3).

Operation time was  $65.2 \pm 46.4$  minutes in the pre-stented group and  $68.8 \pm 40.8$  minutes in the non-stented group, demonstrating no significant difference between the two groups. The stone size was divided into 1 cm intervals. For the patients in the pre-stented group with a stone size of 1 cm or less, operation time was  $40.3 \pm 23.3$  minutes, which was significantly shorter compared with the patients in the non-stented group ( $48.6 \pm 24.5$  minutes). However, there was no significant difference in operative time between the two groups with a stone size of more than 1 cm (Table 4). Even though the age, BMI, sex, Cr level, eGFR, hydronephrosis, and stone characteristics were corrected through propensity matching (Table 1), the operation time in patients with the stone size of more than 1 cm was shorter in the pre-stented group compared with the non-pre-stented group (Table 4).

## Discussion

Flexible RIRS procedure was first introduced by Bagley *et al.* in 1987 (11). Since then, the development of optical technology, the advancement of surgical methods and instruments, and expansion of RIRS have led to an increase in the role of RIRS in primary treatment for kidney stones with a diameter less than 2 cm (1,7,12,13). One of the advanced tools is UAS. UAS in RIRS allows rapid and repeated entry into the ureter and kidney. It also prevents

**Table 1** Patients characteristics according to preoperative ureteral stenting of patients before and after propensity score matching

Variables	Before propensity score matching			After propensity score matching		
	Non-stented group (n=49)	Prestented group (n=73)	P value	Non-stented group (n=49)	Prestented group (n=49)	P value
Mean age (years), mean $\pm$ SD	54.6 $\pm$ 14.6	56.7 $\pm$ 14.0	0.440	54.6 $\pm$ 14.6	55.5 $\pm$ 14.1	0.135
Mean BMI (kg/m <sup>2</sup> ), mean $\pm$ SD	23.3 $\pm$ 8.7	24.4 $\pm$ 2.9	0.413	23.3 $\pm$ 8.7	25.3 $\pm$ 8.7	0.481
Gender, n (%)			0.579			0.416
Male	30 (61.2)	41 (56.2)		30 (61.2)	25 (51.0)	
Female	19 (38.8)	32 (43.8)		19 (38.8)	24 (49.0)	
DM	11 (22.4)	17 (23.3)	0.914	11 (22.4)	11 (22.4)	0.996
HTN	15 (30.6)	30 (41.1)	0.239	15 (30.6)	25 (51.0)	0.064
Cerebrovascular accident, n (%)	1 (2.0)	4 (5.5)	0.348	1 (2.0)	3 (6.1)	0.610
Cardiovascular disease, n (%)	5 (10.2)	6 (8.2)	0.707	5 (10.2)	36.1)	0.712
Preoperative Hb (g/dL), mean $\pm$ SD	13.5 $\pm$ 1.9	12.5 $\pm$ 3.9	0.570	13.5 $\pm$ 1.9	13.7 $\pm$ 4.4	0.711
Preoperative Cr (mg/dL), mean $\pm$ SD	0.97 $\pm$ 0.29	0.97 $\pm$ 0.62	0.966	0.97 $\pm$ 0.29	1.0 $\pm$ 0.7	0.662
Preoperative eGFR (mL/min/1.73 m <sup>2</sup> ), mean $\pm$ SD	68.18 $\pm$ 32.87	79.01 $\pm$ 25.12	0.042	68.18 $\pm$ 32.87	66.42 $\pm$ 32.08	0.560
Laterality, n (%)			0.461			0.102
Right	24 (49.0)	32 (43.8)		24 (49.0)	16 (32.7)	
Left	25 (51.0)	41 (56.2)		25 (51.0)	33 (67.3)	
Density of stone (HU)	837.9 $\pm$ 399.6	915.1 $\pm$ 350.7	0.262	837.9 $\pm$ 399.6	978.5 $\pm$ 388.1	0.080
Max diameter of stone (mm), mean $\pm$ SD	14.47 $\pm$ 8.43	15.27 $\pm$ 10.85	0.662	14.47 $\pm$ 8.43	15.92 $\pm$ 12.06	0.509
Number of stone, n (%) / mean $\pm$ SD	1.90 $\pm$ 1.39	2.33 $\pm$ 2.35	0.206	1.90 $\pm$ 1.39	2.33 $\pm$ 2.35	0.839
1	28 (57.1)	35 (47.9)		28 (57.1)	30 (61.2)	
2	9 (18.4)	17 (23.3)		9 (18.4)	8 (16.3)	
$\geq$ 3	12 (24.5)	21 (28.8)		12 (24.5)	11 (22.4)	
Hydronephrosis, n (%)			0.424			0.483
None	21 (42.9)	33 (45.2)		21 (42.9)	18 (36.7)	
Mild	9 (18.4)	11 (15.1)		9 (18.4)	8 (16.3)	
Moderate	6 (12.2)	16 (21.9)		6 (12.2)	12 (24.5)	
Severe	13 (26.5)	13 (17.8)		13 (26.5)	11 (22.4)	
Stone location, n (%)			0.564			0.435
Pelvis	30 (61.2)	46 (63.0)		30 (61.2)	31 (63.3)	
Upper pole	13 (26.5)	21 (28.8)		13 (26.5)	12 (24.5)	
Mid pole	13 (26.5)	24 (32.9)		13 (26.5)	13 (26.5)	
Lower pole	23 (46.9)	38 (52.1)		23 (46.9)	25 (51.0)	

Table 1 (continued)

Table 1 (continued)

Variables	Before propensity score matching			After propensity score matching		
	Non-stented group (n=49)	Prestented group (n=73)	P value	Non-stented group (n=49)	Prestented group (n=49)	P value
Stone composition, n (%)			0.745			0.915
Calcium oxalate monohydrate	34 (69.4)	45 (61.6)		34 (69.4)	34 (69.4)	
Calcium oxalate dihydrate	1 (2.0)	1 (1.4)		1 (2.0)	1 (2.0)	
Carbonate apatite	2 (4.1)	6 (8.2)		2 (4.1)	3 (6.1)	
Uric acid	11 (22.4)	20 (27.4)		11 (22.4)	12 (24.5)	
Struvite	1 (2.0)	1 (1.4)		1 (2.0)	1 (2.0)	

SD, standard deviation; BMI, body mass index; Cr, creatinine; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; Hb, hemoglobin; HTN, hypertension; HU, Hounsfield units.

Table 2 Perioperative outcomes according to preoperative ureteral stenting before and after propensity score matching

Variables	Before propensity score matching			After propensity score matching		
	Non-stented group (n=49)	Prestented group (n=73)	P value	Non-stented group (n=49)	Prestented group (n=49)	P value
Intraoperative complication, n (%)	0 (0)	3 (4.1)	0.151	0 (0.0)	1 (2.0)	0.932
Intraoperative transfusion, n (%)	0 (0)	1 (1.4)	0.411	0 (0.0)	0 (0.0)	N/A
Access sheath successful insertion, n (%)	43 (87.8)	71 (97.3)	0.038	43 (87.8)	49 (100.0)	0.035
Postoperative UTI, n (%)	3 (6.1)	6 (8.2)	0.664	3 (6.1)	3 (6.1)	1.000
Stone free rate 0 mm, n (%)	34 (69.4)	53 (72.6)	0.700	34 (69.4)	41 (83.7)	0.064
Stone free rate <4 mm, n (%)	43 (87.8)	65 (89.0)	0.827	43 (87.8)	41 (83.7)	0.132
Additional treatment, n (%)	4 (8.2)	6 (8.2)	0.991	4 (8.2)	3 (6.1)	0.964
Operative time (min), mean ± SD	68.8±40.8	65.2±46.4	0.664	68.8±40.8	68.1±48.9	0.932
Hospitalization period (days), mean ± SD	1.3±0.8	1.2±0.8	0.678	1.3±0.8	1.2±0.4	0.321
Postop. period with stent (days), mean ± SD	14.0±8.2	15.8±15.8	0.471	14.0±8.2	15.0±17.3	0.711
Postoperative ureteral stricture, n (%)	1 (4.0)	1 (1.4)	0.653	1 (4.0)	1 (1.3)	0.653

UTI, urinary tract infection; NA, not available; SD, standard deviation; N/A, not available.

pyelovenous backflow during surgery and maintains low renal pressure, thus lowering renal injury while providing a better view (4,14-17). Despite the usefulness of UAS, we cannot insert UAS into the ureter during every surgery. In previous studies, the failure probability of UAS insertion varied from 3% to 22% (9,18-20). The causes of failure of UAS insertion is usually because of narrow ureter orifices

or narrow ureter diameters relative to the diameter of the UAS. The diameter of the native ureter is usually 6–9 Fr, and the diameter of the outer sheath of a commonly used UAS is 11–14 Fr (21). In the case of RIRS without UAS, the renal pelvis pressure increases, and the increased pressure forms a pyelovenous backflow. The increased pyelovenous backflow leads to renal damage or increased infection

**Table 3** Perioperative complication according to Clavien-Dindo classification

Variable	Before propensity score matching			After propensity score matching		
	Non-stented group (n=49)	Prestented group (n=73)	P value	Non-stented group (n=49)	Prestented group (n=49)	P value
Intraoperative ureter injury (grade III)	0 (0.0)	3 (4.1)	0.151	0 (0.0)	1 (2.0)	0.932
Intraoperative bleeding (grade II)	0 (0.0)	1 (1.4)	0.411	0 (0.0)	0 (0.0)	N/A
Postoperative UTI	3 (6.1)	6 (8.2)	0.664	3 (6.1)	3 (6.1)	1.000
Urinary tract infection (grade II)	1 (2.0)	5 (6.8)		1 (2.0)	2 (4.1)	
Acute pyelonephritis (grade II)	1 (2.0)	1 (1.4)		1 (2.0)	1 (2.0)	
Sepsis (grade IVa/IVb)	1 (2.0)	0 (0.0)		1 (2.0)	0 (0.0)	
Postoperative ureteral stricture (grade III)	1 (4.0)	1 (1.4)	0.653	1 (4.0)	1 (1.3)	0.653

UTI, urinary tract infection.

**Table 4** Operation time according to stone size in propensity matching

Size of stone (cm)	Before propensity score matching, mean ± SD			After propensity score matching, mean ± SD		
	Non-stented group (n=49)	Prestented group (n=73)	P value	Non-stented group (n=49)	Prestented group (n=49)	P value
<1	48.6±24.5	40.3±23.3	0.019	48.6±24.5	37.5±25.0	0.004
1–2	67.6±34.2	64.2±48.4	0.777	67.6±34.2	70.6±49.6	0.588
≥2	128.5±46.9	93.9±52.2	0.214	128.5±46.9	100.6±51.4	0.319

SD, standard deviation.

risk. As such, UAS insertion may be closely related to postoperative complications (22).

In the present study, the success rate of UAS insertion was significantly higher in the prestented group (97.3%) compared to the non-stented group (87.8%) with  $P=0.038$ . The indwelling preoperative ureteral stent showed a significant difference in success rates of UAS insertion. Mogilevkin *et al.* reported that the prestented ureteral catheter was effective for UAS insertion and was an independent predictor of UAS insertion in multivariate analysis (23). The manually inserted preoperative ureteral stent enlarges the ureter and ureter orifice, corrects the kinking, and corrects the position of the ureter. The changes in the ureter help to increase the success rate of UAS insertion (20–22).

In the present study, the indwelling preoperative ureteral stent shortened the operation time for patients with stone sizes  $\leq 1$  cm. Stones less than 1 cm were 25.9% in the prestented group and 27.1% in the non-stented group. Stones less than 8 mm were 16.5% in the prestented group and 17.6% in the non-stented group. Stones less than 4 mm

were 1% in the prestented group and 3.5% in the non-stented group. There was no significant difference between the two groups. The prestented ureteral stent could extend the ureteropelvic junction and dilate the ureter, enabling easier access, basket stone retrieval and better view (24). A UAS can be easily inserted in the case of prestented patients. And it is sensible that smaller stones could be easily removed from a dilated ureter. In patients with stones less than 1 cm, fragmentation was performed in large pieces rather than dusting, and the number of stones retrieved was smaller compared to relatively large stones, and the field of view after fragmentation was good, which could have affected the operation time. In previous studies, there was no significant difference in operation time between with and without preoperative stents in patients with kidney stones (9,18–20). A few studies reported the difference in operation time according to preoperative stent placement (10). On the contrary, Chu *et al.* reported that preoperative ureter stent insertion can significantly reduce operative time in patients with stones greater than 1 cm (10). The difference in stone burden, the difference in diameter of the access sheath,

and the method of stone fragmentation were not corrected between these studies.

A significant difference in preoperative eGFR was observed ( $P=0.042$ ). The value of eGFR was  $68.18 \pm 32.87$  mL/min/1.73 m<sup>2</sup> in the non-stented group and  $79.01 \pm 25.12$  mL/min/1.73 m<sup>2</sup> in the prestented group. It is hypothesized that the ureter stent might have solved the obstruction caused by renal stone and upper ureter stone. Several studies have reported that preoperative ureteral stent indwelling can affect the outcome of RIRS (25,26).

This study has some limitations. First, it was a retrospective study. Second, we did not perform random preoperative stent insertion. Therefore, there is a possibility of the presence of selection bias. However, preoperative ureter catheter insertion is more likely to be performed for difficult or symptomatic cases. It is believed that correction of adverse conditions would generate more significant results. Third, although propensity matching was conducted, the number of patients was limited, and the power of the conclusions obtained may be insufficient.

## Conclusions

Our results showed that preoperative ureteral stenting can reduce operation time in RIRS for stones with diameters less than 1 cm. Apparently preoperative ureteral insertion can be considered for surgery requiring successful placement of the UAS.

## Acknowledgments

*Funding:* This work was supported by the 2010 Inje University research grant.

## Footnote

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/tau.2020.03.09>). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was approved by the Institutional Review Board of Inje University Sanggye Paik Hospital (approval code: H-2018-

10-003). This was a retrospective study and exempted from patient written consent.

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**Cite this article as:** Sung LH, Cho DY. The role of preoperative ureteral stenting in retrograde intrarenal surgery in renal stone patients: a propensity score-matched study. *Transl Androl Urol* 2020;9(2):276-283. doi: 10.21037/tau.2020.03.09