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ORIGINAL PAPER

External validation of Resorlu-Unsal stone score in predicting outcomes after retrograde intrarenal surgery. Experience from a single institution

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Summary ***Objective: Pre-operative assessment of renal stones is essential in selecting treatment options and achieving high success rates for retrograde intrarenal surgery (RIRS). Several nephrolithometric scoring systems have been developed using pre-operative clinical data and stone characteristics. Resorlu-Unsal stone score (RUSS) is composed of four different parameters, and each of them adds 1 point to the final score. One point is added in patients with stone size > 20 mm, lower calyceal stones and infundibulo-pelvic angle < 45°, stone number > 1, and abnormal anatomy, respectively. RUSS categorizes patients into four distinct groups and aims to predict stone-free rates (SFR) after RIRS. We externally validated RUSS and evaluated its predictive accuracy.***
Materials and Methods: We performed a retrospective analysis of patients who underwent RIRS for renal stones between January 2020 and December 2021. Patient age, pre-operative hydronephrosis, stone size, stone density as Hounsfield Unit (HU), operative time and RUSS were investigated as potential preoperative predictive factors for stone-free status. RUSS was applied to all patients, and the nomogram was externally validated. Area under the curve (AUC) was used for clinical validity assessment.
Results: The present study included a total of 79 patients. Mean patient age was 55.1 ± 15.4 years with a mean stone size was 14.2 ± 4.4 mm. Overall, 62/79 (78.4%) patients were stone free after the initial treatment. After applying RUSS, 36 (45.6%), 29 (36.7%), 10 (12.6%), and 4 (5.1%) patients had a score of 0, 1, 2, and 3, respectively. On multivariate logistic regression RUSS (OR = 0.220; 95%CI: 0.086-0.567; p = 0.002) was identified as the only predictor of postoperative stone-free status.
Conclusions: RUSS is a user-friendly scoring system that may predict postoperative stone-free rate after RIRS with great efficacy and accuracy.

KEY WORDS: *Stone; Kidney; Endoscopic; RIRS; Stone free rate.*

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INTRODUCTION

Urolithiasis is a common and worldwide increasing disease in developed countries (1). According to the *European Association of Urology* (EAU) guidelines, the treatment of kidney stones depends mainly on their size and location. In particular, stones larger than 20 mm should be managed with *percutaneous nephrolithotomy* (PCNL), while, below this threshold, the *retrograde intrarenal surgery* (RIRS) and *extracorporeal shock-wave lithotripsy* (ESWL) are the treatments of choice (2-4). However, the continuous technological development and the use of increasingly powerful and safe instruments and techniques broadened the role of RIRS also for stones > 20 mm (5-7).

Stone free rate (SFR) remains one of the primary outcomes after endoscopic surgery for kidney stones. Recently, different scores to predict SFR have been formulated for patients undergoing RIRS; such as the R.I.R.S. score, the *Seoul National University Renal Stone Complexity* (S-ReSC) and the *Resorlu-Unsal stone score* (RUSS) (8-10). This latter score was conceived in 2012, and takes in consideration the stone size, its presence at the level of the lower calyces, the *infundibulum-pelvic angle* (IPA), the number of stones and anatomical alterations. The goal of our study is to externally validate the applicability of RUSS in a single-center cohort of patients undergoing RIRS for kidney stones.

MATERIALS AND METHODS

We retrospectively reviewed medical data of 79 patients who underwent RIRS between January 2020 and December 2021 at single center institution.

Two expert surgeons, highly experienced in RIRS (> 500 procedures) performed the operations in a standardized fashion.

All procedures were made with patient in lithotomy position under general anesthesia. Preoperative single-dose antibiotic prophylaxis was used for all patients. A *ureteral access sheath* (UAS) (*Flexor, Cook Medical, Bloomington, USA*) was inserted under fluoroscopic control if the ureter was compliant, with its tip always above the ureteral-pelvic junction. Therefore, the correct irrigating fluid outflow was confirmed and a 7.5 Ch flexible ureteroscope was inserted (*Flex X2s, Karl Storz, Tuttlingen, Germany*). Laser lithotripsy was carried out with a 20w Holmium-YAG laser (*EMS Laser Clast, Electro Medical Systems, Nyon, Switzerland*), using a 200-micron fibre. Laser setting was

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5-12 Hz and 0.6-1.2 J, either long or short pulse width. Gravity irrigation was always used during lithotripsy and an additional intermittent gentle manual irrigation with a 60 ml syringe was added for a short time in case of reduced visibility. Irrigating fluid outflow was checked continuously during the whole procedure. Residual fragments were removed using a 2.2 Fr-1 cm Nitinol basket (*N-Circle, Cook Medical, Bloomington, USA*). At the end of the procedure, a final inspection of the upper urinary tract was performed with the aim to detect any residual fragments or ureteral injuries.

Our inclusion criteria were: 1) patients > 18 years; 2) preoperative *non-contrast computed tomography* (NCCT) documenting a kidney stone > 10 mm.

Exclusion criteria were: 1) patients with concurrent ureteral stone or with bilateral renal stones; 2) with prior double J catheter; 3) with ureteral strictures; 4) patients without complete clinical records.

Clinical data and stones characteristics were collected for each patient. Stone burden was interpreted as the two-dimensional area determined by multiplying the longest diameter by the perpendicular diameter of the stone. In case of multiple stones, the stone burden was defined as the cumulative size. Operation time was intended from the beginning of the cystoscopy to the end of the ureteral placement. A score (between 0 and 4) according to RUSS was assigned to each patient. This score system is based on four criteria, each having equal weight (1 point); stone size > 20 mm, lower pole stone location with IPA < 45°, number of stones in different calyces (> 1) and presence of abnormal renal anatomy (horseshoe kidney or pelvic kidney). The IPA was measured as the inner angle between the ureteropelvic axis and central axis of the lower pole infundibulum as described by *Elbahnasy et al.* (11).

The stone-free status was described as the absence of any residual stone fragment ≥ 5 mm at 1 month after surgery follow-up NCCT. Complications were recorded according to Clavien-Dindo classification.

Statistical analysis was carried out using SPSS software version 27 (*SPSS Inc, Chicago, USA*). Continuous variables are presented as means and standard deviations. Categorical variables are described by their absolute number and percent frequency. A multivariable logistic COX regression analysis was used to identify independent predictors of SFR. The AUC, calculated by *receiver operating characteristics curves* (ROC) of RUSS was used to assess predictive accuracy of SFR.

All p values were two-tailed, with statistical significance set at 0.05 and confidence intervals at 95 % level.

Results

The patients and stones characteristics are shown in Table 1. Overall, 79 patients were included. Of those, 41 (51.9%) were males. Mean patient age was 55.1 ± 15.4 years and mean stone size was 14.2 ± 4.4 mm with a mean stone density of 1014.4 ± 276 HU. Left side was the most interested, n= 49 (69.1%). With regards to the intrarenal location, 23 (29.1%), 29 (36.7%) and 27 stones (34.2%) were located in the upper, middle and lower calyx, respectively. A total of 3 patients had ectopic kidney and 1 presented with horseshoe kidney. After applying RUSS, 36 (45.6%), 29 (36.7%), 10 (12.6%), and 4 (5.1%) patients had a score of 0, 1, 2, and 3, respectively. Perioperative and postoperative data are shown in Table 2. Overall, 62/79 (78.4%) patients were stone free after the initial treatment. The mean operation time was 75.3 (± 26.6) minutes. Mean hospital stay was 1.6 ± 0.9 days. A total of 2 urosepsis occurred and were treated with appropriate antibiotic therapy with one of them requiring intensive care unit admission; 5 postoperative fever and 1 migration of the double J catheter were also recorded.

After adjusting logistic multivariate COX regression

Table 1.
Patients' demographic and stone characteristics.

Variable	Overall n = 79
Age at surgery (mean, SD)	55.1 (± 15.4)
Gender (n, %)	
Male	45 (56.9%)
Female	34 (43.1%)
ASA score (n, %)	
1-2	71 (89.9%)
3-4	8 (10.1%)
Hydronephrosis (n,%)	16 (20.3%)
Laterality (n, %)	
Left	54 (68.4%)
Rigth	25 (31.6%)
Stone size, mm^2	14.2 (4.4)
Stone density, HU	1014.4 (276)
Stones, mean (SD)	1.6 (± 0.9)
Stone location	
Upper calyx	23 (29.1%),
Middle calyx	29 (36.7%)
Lower calyx	27 (34.2%)
Urinary Anomaly (n, %)	
Horseshoe kidney	1 (1.3%)
Pelvic kidney	3 (3.8%)

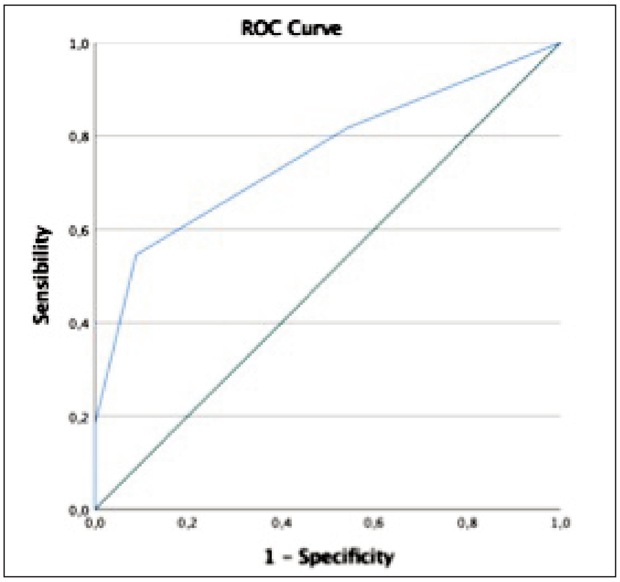
Table 2.
Perioperative and postoperative outcomes.

Variable	Overall n = 79
Operative Time, min (mean, SD)	75.3 (± 26.6)
LOS, days (mean, SD)	1.6 (0.9)
Overall complications (n, %)	7 (8.9%)
Clavien Grade (n, %)	
I	6 (7.6%)
II	1 (1.3%)
III	-
IV	1 (1.3%)
V	-

Table 3.
Binary logistic Cox regression analysis for predictors for postoperative stone-free status.

Variable	OR	Lower	Higher	P value
Age	1.006	0.956	1.149	0.766
Hydronephrosis	0.724	0.194	2.705	0.331
Stone size, mm	0.955	0.859	1.152	0.448
Stone density, HU	0.992	0.890	1.047	0.806
Operative time	0.982	0.749	1.156	0.499
RUSS	0.220	0.086	0.567	0.002

Figure 1.
Predictive accuracy of RUSS.



analysis for age, preoperative hydronephrosis, stone size, stone density, RUSS and operative time, only RUSS (OR = 0.220; 95%CI: 0.086-0.567; p = 0.002) was identified as a statistically significant predictor of postoperative stone-free status (Table 3). Finally, accuracy of RUSS reached an AUC of 0.76 (Figure 1).

Discussion

According to EAU guidelines, PCNL is the standard of treatment for renal stones > 2 cm. Whilst, treatment for renal stones < 2 cm should be performed with either RIRS or ESWL. However, the progressive technological improvements in flexible ureterorenoscopy and new performing lasers have extended the surgical indications for kidney stones reaching a comparable success rate for stones > 2 cm in experienced hands and well selected patients (12, 13).

Notably, several predictive score systems have been recently incorporated in everyday clinical practice in order to predict outcomes following RIRS.

Our aim was to externally validate the RUSS score, conceived by *Resorlu et al.* in 2012, on an Italian cohort of patients.

To the best of our knowledge, the present study is the first external validation of RUSS performed in an Italian center. Our analysis brought to several noteworthy findings.

First, males and left kidney side were the most interested accounting for 56.9% and 68.4%, respectively.

Second, when adjusting SFR status on multivariable analysis, neither stone density nor stone size reached statistical significance (OR: 0.99; p = 0.80 and OR: 0.95; p= 0.44). Conversely, RUSS was identified as the only predictive score for SFR (OR: 0.32; p = 0.002). This is in agreement with *Selmi et al.* who in a pooled comparison of different nephrolithometric scores showed that RUSS was the best predictor of SFR (OR: 0.45) (14).

Third, in the present study overall SFR was 78.4%, this rate being in line with results reported from other studies on RIRS series (15-17).

Fourth, RUSS registered an AUC of 0.76. Similarly, *Sfoungaristos et al.* RUSS externally validated RUSS estimating an AUC of 0.70 (18). Interestingly, results from a recent metanalysis comparing the predictive ability of the most used scoring systems for SFR has not revealed any superiority of one scoring tool over another (19). However, the high heterogeneity between studies and variables between the scoring systems make difficult to statistically generalize these findings.

Taken together, RUSS is a simple and reliable score to apply during the preoperative evaluation of kidney stones. For sure IPA is the most demanding parameter to calculate for urologists, however after a short learning curve with an expert radiologist we were able to perfectly assess this angle.

We acknowledge that the present study has some limitations. First, should be interpreted in the context of its retrospective nature. Second, the sample size is relatively small and includes fewer cases with high scores for the scoring system. Third, RIRS is strongly dependent on operator's skill and potential risk of bias can occur. However, we only selected cases that were performed by expert surgeons in the RIRS field. Fourth, the RUSS score has an intrinsic limitation: horseshoe and ectopic kidneys are relatively rare. Therefore, only a restricted number of patients scored 3 points. For this reason, our results may overestimate the diagnostic accuracy of this technique and potentially undermine their reproducibility in clinical practice. Further validation studies with larger cohorts are needed to confirm the diagnostic accuracy of RUSS.

Conclusions

Treatment planning of kidney stones relies on several predictive scores. RUSS represents a user-friendly scoring tool that can be used in the prediction of postoperative SFR after RIRS. Further external validations in larger cohorts are needed to confirm these results.

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