# Retrograde Intrarenal Surgery in Children with Kidney Stones: Single Surgeon Experience

## Böbrek Taşı Olan Çocuklarda Retrograd Intrarenal Cerrahi: Tek Cerrah Deneyimi

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**ABSTRACT**

**Introduction:** In the recent years, there has been a significant rise in paediatric stone disease population, hence with the advancement of technology, new minimally invasive treatment methods have been developed like percutaneous nephrolithotomy, retrograde intrarenal surgery (RIRS), shock-wave lithotripsy (SWL) and laparoscopic stone surgeries.
**Objective:** In this study, we aimed to evaluate the data of paediatric RIRS cases performed by single surgeon in our clinic and to affirm the effectiveness and reliability of this method in treatment of kidney stones in children.
**Patients and Method:** The data of 29 patients (13 boys and 16 girls) under 18 years of age who underwent RIRS due to kidney stones between April 2012 and September 2019 were analyzed retrospectively. All the operations were performed by the same surgeon. Urinary system x-ray, ultrasonography (USG) and non-contrast computed tomography (CT) scans were used to determine the urinary tract anatomy and stone characteristics.
**Results:** The median age of 29 children was 8 (1-17) years. The mean stone diameter was determined as 11.4 ±0.875mm, 17(58.6%) patients had solitary stones and 12(41.4%) patients had multiple stones. In 7(24.1%) patients stones were situated in the renal pelvis, while 14(48.3%) were in lower calices and 8(%27.6) were in middle/upper calices. Ureteral access sheath was inserted in 11(38%) patients during the procedure, but not in the remaining 18(62%). The mean fluoroscopy time was 12±0.735sec. Double-J (DJ) stent was placed in all patients at the end of the procedure. The mean length of hospital stay was 1.2 days. The stone-free rate was 72.4% at the end of single session, 2(6.9%) patients received a second-look RIRS, and SWL was performed in 1(3.4%) patient postoperatively. Stone-free status was achieved in both patients after the second RIRS thus the final overall stone-free rate for RIRS was 79.3%. Postoperative febrile urinary tract infection developed in 1(3.4%) patient.
**Conclusion:** RIRS is a minimally invasive treatment method in kidney stones that can be performed safely with high success rates in the paediatric age group within the appropriate indication.

**Keywords:** Paediatric urology; endourology; urinary stone disease; retrograde intrarenal surgery

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**ÖZET**

**Amaç:** Son yıllarda pediatrik taş hastalığı popülasyonunda önemli bir artış olması nedeniyle teknolojinin de ilerlemesi ile perkütan nefrolitotomi, retrograd intrarenal cerrahi (RIRS), şok dalga litotripsi (SWL) ve laparoskopik taş ameliyatları gibi yeni minimal invaziv tedavi yöntemleri geliştirilmiştir. Bu çalışmada, kliniğimizde tek cerrah tarafından uygulanan pediatrik RIRS vakalarının verilerini değerlendirmeyi ve bu yöntemin çocuklarda böbrek taşı tedavisinde etkinliğini ve güvenilirliğini doğrulamayı amaçladık.
**Yöntem:** Nisan 2012-Eylül 2019 tarihleri arasında böbrek taşı nedeniyle RIRS uygulanan 18 yaş altı 29 hastanın (13 erkek ve 16 kız) verileri retrospektif olarak incelendi. Tüm operasyonlar aynı cerrah tarafından yapıldı. İdrar yolu anatomisini ve taş özelliklerini belirlemek için direkt üriner sistem grafisi, ultrasonografi (USG) ve kontrastsız bilgisayarlı tomografi (BT) taramaları kullanıldı.
**Bulgular:** 29 çocuğun ortanca yaşı 8 (1-17) idi. Ortalama taş çapı 11.4 ±0.875 mm olarak belirlendi, 17(%58.6) hastada tek, 12(%41.4) hastada multipl taş saptandı. Hastaların 7'sinde (%24.1) taş renal pelviste, 14'ünde (%48.3) alt kalikslerde, 8'inde (%27.6) orta/üst kalikslerdeydi. İşlem sırasında 11(%38) hastaya üreteral kılıf takılırken, kalan 18(%62) hastaya üreteral kılıfsız operasyon uygulandı. Ortalama floroskopi süresi 12±0.735sn idi. İşlem sonunda tüm hastalara Double-J (DJ) stent yerleştirildi. Ortalama hastanede kalış süresi 1.2 gündü. Tek seans sonunda taşsızlık oranı %72.4, 2(%6.9) hastaya ikinci seans RIRS, 1(%3.4) hastaya ameliyat sonrası rezidü taşlar için SWL uygulandı. İkinci seans RIRS'den sonra her iki hastada da taşsızlık durumu elde edildi, bu nedenle RIRS için nihai genel taşsızlık oranı %79.3 oldu. 1 (%3.4) hastada postoperatif ateşli idrar yolu enfeksiyonu gelişti.
**Sonuç:** RIRS, böbrek taşı olan çocuk hastalarda uygun endikasyon dahilinde yüksek başarı oranları ile güvenle uygulanabilen minimal invaziv bir tedavi yöntemidir.

**Anahtar Sözcükler:** Pediatrik üroloji; endoüroloji; üriner taş hastalığı; retrograd intrarenal cerrahi

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## INTRODUCTION

The prevalence of urinary stone disease under the age of 18 is nearly 1-2% (1). However, in recent years, there has been a significant rise in paediatric stone disease rates. This increase is thought to be due to sedentary lifestyle and carbohydrate and salt-weighted diet. Hence, new minimally invasive treatment methods have been developed like percutaneous nephrolithotomy, retrograde intrarenal surgery (RIRS), shock-wave lithotripsy (SWL) and laparoscopic stone surgeries (RALS-UL). The most appropriate treatment method is chosen according to the stone characteristics like location, burden, hardness and anatomic structure of the urinary tract(2). Ureteroscopy was first performed by Enrique Perez Castro in 1980, while RIRS was by Huffman in 1983. By the development of Holmium laser and gentler instruments, these surgeries have become easier and more effective in children. Accordingly RIRS complications are becoming rare and mostly as minor complications. However, the golden rule in endoscopic interventions is to never use force and do nothing without clearly seeing. The aim of stone surgeries is to achieve maximum stone-free rates with minimum morbidity. RIRS is also less invasive than percutaneous nephrolithotomy and open pyelolithotomy operations(3).

## PATIENTS and METHODS

The data of 29 consecutive patients (13 boys, 16 girls) under 18 years of age who underwent RIRS owing to kidney stones between April 2012 and September 2019 at our University institution were analyzed retrospectively. All the operations were performed by the same surgeon. Complete blood count and serum biochemistry parameters, coagulation and immunology tests, urinalysis and urine cultures were carried out in all patients preoperatively. Urinary system x-ray (DUSG), ultrasonography (USG) and non-contrast computed tomography (CT) scans were used to determine the urinary tract anatomy and stone characteristics. Patients went under surgery after proving a negative urine culture and all the children received antibiotic prophylaxis. In 9(31%) patients a double-J (DJ) stent was inserted 3 weeks prior to RIRS to gain passive dilation. The operations were performed in the supine lithotomy position under general anaesthesia and fluoroscopy control. At the beginning of the operation, the bladder was drained with the cystoscope. Subsequently, the ureter was entered with a semi-rigid 6F Wolf ureteroscope for dilation using a guide wire that was left in the ureter. Subsequently the ureteral sheath and/or the flexible ureteroscope were advanced under fluoroscopic guidance over the guide wire. In 11(38%) patients, a ureteral access heath (UAS), 9.5F Cook Medical brand, was used while 18 (62%) patients were operated without. Olympus flexible fiberoptic ureteroscope (URF-P6) 7,95 Fr was used through the UAS or under fluoroscopic guidance over the guide wire to visualize , and treat the renal calculi via Holmium: YAG laser lithotripter(Figure-1). The stones were fragmented as small as possible to allow spontaneous passage. In all children DJ stents were left indwelling for drainage and removed after 6-8 weeks. The stone-free rates were determined by DUSG, USG and/or CT scans at postoperative 3rd months(Figure-2).

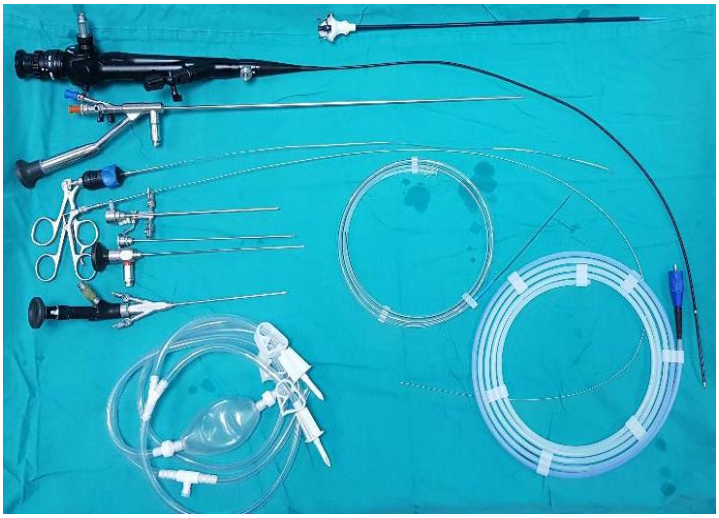

**Figure 1:** Endoscopes and other materials

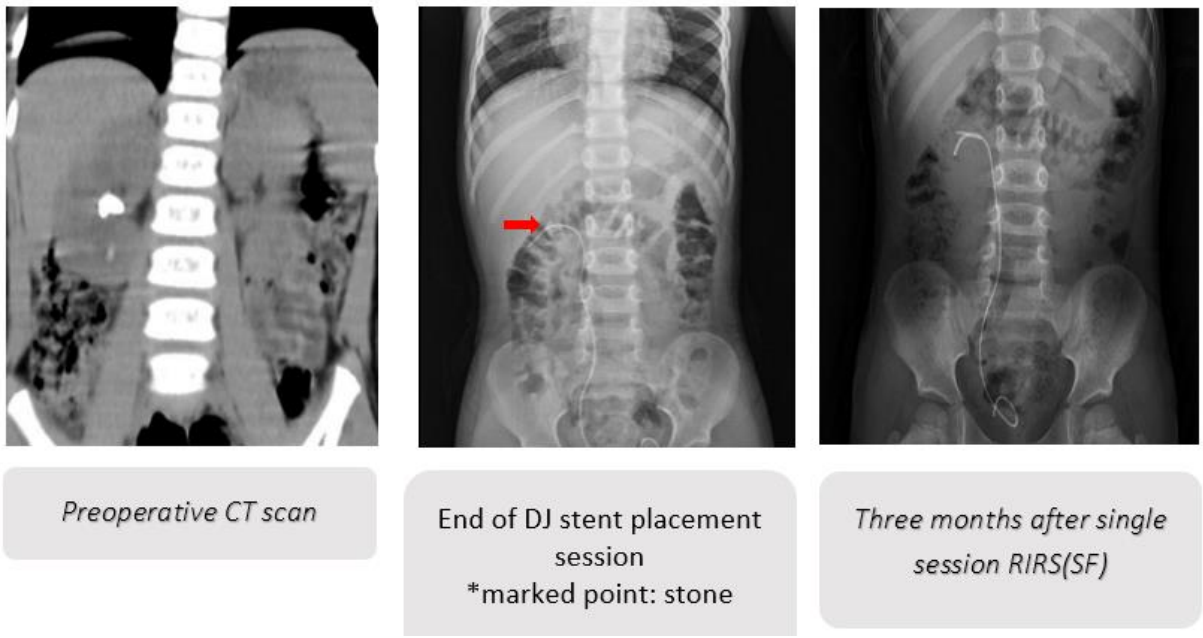


**Figure 2:** A patient's pre and post-operative images

### Statistical analysis

Statistical analysis was done using the Statistical Package for Social Sciences (Version 24.0, SPSS Inc., IL, USA, Licence Gazi University). Descriptive statistics were expressed as the mean ± standard deviation for the continuous variables or median (min-max) and the number and percentage for the categorical variables depending on the distribution of the data. Normality was evaluated with Shapiro-Wilk test. Since parametric test hypotheses were not provided for the comparison of two independent mean values, non-parametric Mann-Whitney U test was used. Statistical significance was accepted as $p < 0.05$.

## RESULTS

The median age of the study group was 98(1-17) months. The mean stone diameter was determined as 11.4 ±0.875mm, 17(58.6%) patients had solitary stones and 12(41.4%) patients had multiple stones. In 7(24.1%) patients stones were situated in the renal pelvis, while 14(48.3%) were in lower calices and 8(%27.6) were in middle/upper calices. Preoperative DJ stent was inserted in 9 (31%) patients. In this series UAS was used in 11 (38%) patients while it was not appropriate, suitable or possible in 18 (62%) children. Thus, the mean age of UAS inserted children was 12 ± 3.8 years, while the others were markedly small children with a mean age of 5.6±3.9 years that significantly different (p = 0.001). The mean fluoroscopy time was 12 ± 0.735sec. All patients had DJ stent inserted at the end of the procedure. The mean length of hospital stay was 1.2 days. Postoperative febrile urinary tract infection (Clavien 2) requiring antibiotic treatment developed in 1(3.4%) patient. The stone-free rate after first RIRS was 72.4% (in 21 patients) (Table-1). Due to residual stones, 2 (6.9%) patients underwent a second session RIRS, and 1(3.4%) patient had SWL. Stone-free status was achieved in both patients after the second RIRS thus the final overall stone-free rate for RIRS was 79.3%.

**Table 1:** Clinical characteristics of patients and treatment outcomes

| | |
|---|---|
| Age-median(min-max) | 8(1-17) years |
| Stone diameter-mean | 11.4(SD± 0.875) mm |
| Number of stone | |
| Single | 17(58.6%) |
| Multiple | 12(41.4%) |
| Stone localization | |
| Pelvis | 7(24.1%) |
| Lower calyx | 14(48.3%) |
| Middle/upper calyx | 8(27.6%) |
| Ureteral access sheath | |
| (+) | 11(38%) |
| (-) | 18(62%) |
| Fluoroscopy duration-mean | 12(SD± 0.735) sec |
| Stone-free Rate | |
| After 1 session | 21/29(72.4%) |
| After 2 sessions | 23/29(79.3%) |

## DISCUSSION

Kidney stone treatment options in children are similar to adults including SWL, PCNL, RIRS, and laparoscopic and robotic surgery(4).The application of SWL in children was first described in 1986(5). SWL is recommended as the first choice of treatment in kidney stones smaller than 2 cm (4, 6). However, SWL has limited efficacy with low stone-free rates in treatment of lower pole stones and hard stones such as cystine and calcium oxalate monohydrate(7-9). Accordingly determination of stone density on non-contrast CT images in Hounsfield Units(10) as calcium (HU> 1000) or non-calcium (HU <700) stones could aid in the choice of appropriate treatment. The disadvantages of SWL are complications; such as subcapsular hematoma, probable renal parenchyma and adjacent organ damage, ureteral obstruction due to stone-street formation, infection; need for anaesthesia and the possibility of multiple sessions requiring time, compliance and follow up(5, 11)Endoscopic intracorporeal lithotripsy technologies (pneumatic, ultrasonic, holmium laser, thulium laser) are available for PCNL, RIRS, and URS surgeries. Pneumatic lithotripsy is an inexpensive, durable and reusable technology which is effective in large and hard stones (12). The main disadvantage of this device is the rigidity of the probe that makes it inappropriate to use with flexible instruments. It could also cause push back of stones from the proximal ureter to the renal pelvis. Ultrasonic lithotripters are effective and commonly used in standard PCNL for patients with high stone burden but could be less effective than pneumatic lithotripters for hard stones (5). The development of Holmium laser provided great progress in endoscopic stone surgery. This technology uses various power devices (20W-120W) and laser fibers (200-1000µm) thus lithotripsy can be applied with various energy and frequency adjustments. Stone fragmentation method can be performed with high energy-low frequency and dusting method with low energy-high frequency(13). Recent laser devices have different modes as “moses effect” and “burst mode”. In the "Moses effect" mode, the device gives diphasic pulses and reduces the possibility of stone push-back(14). In “Burst mode”, there are 3 laser pulses with different lengths per explosion. With this method, 60% more stone fragmentation is possible(15, 16). Thulium laser technology is 2-4 times faster and has minimal stone push-back effect compared to Holmium laser(17).

Percutaneous nephrolithotomy is the first-line treatment method for kidney stones larger than 2 cm (18). This surgery can be performed in prone, supine and lateral positions (5). Smaller tools have been developed for paediatric patients and as a result, mini PCNL (14-20F), ultra mini PCNL (11-13F) (19), micro PCNL (4.8F) (20), mini micro PCNL (8F), super mini PCNL (10-14F) percutaneous nephrolithotomy surgeries have been described (21). They can be used also in combination with PCNL and RIRS (22).

RIRS, which is frequently used in kidney stones smaller than 2 cm, is increasingly being recommended as a safe treatment option in children with high stone-free rates (23). By the development of thinner and more flexible instruments and Holmium laser, performing RIRS in the upper ureter and kidney stones has increased (23). In the literature review, the stone-free rate of children who underwent RIRS is 58-100% and complication rates are found as 0-8.4% (24). This wide range of ratios can be related to the heterogeneity in the age of study groups and surgical experience. The overall stone-free rate (79.3%) and complication rate (3.4%) in our study were found to be compatible with the literature. UAS has advantages such as decreasing intrarenal pressure, increasing the stone-free rate and shortening the operation duration (25). However, use of UAS in paediatric patients can be difficult due to the narrowness the ureter. In our study, UAS could not have been placed in children significantly smaller than others, namely with a mean age of 5.6±3.9 years. Traxer et al. Reported ureteral injuries during UAS insertion in 167 patients among a study group with 369 adult patients (26). In our study no ureteral injuries or UAS related complications have developed. However the series is small. Skipping access sheath insertion in case of resistance, beware-avoidance in small children, placing the sheath-working always under fluoroscopy, ureteral dilation and/or prior stenting could be the recommendations in ureteral endoscopic surgery to minimize the complications. However, ureteral surgery could have serious complications such as ureteral avulsion, stricture formation and sepsis, thus surgeon’s experience with the use of appropriate miniature instruments and advanced technology rather than available in units and good technique are strictly essential in ureteral endoscopy and more essential in retrograde intrarenal surgery.

A systematic review has recently been published, including 13 studies comparing SWL, PCNL and RIRS in paediatric upper urinary tract stone disease (27). In this systematic review, SWL has lower stone-free rate (SFR) and higher rate of retreatment than the other two methods; PCNL has been shown to have a higher rate of stone-free than RIRS, but longer hospitalization and longer operation and fluoroscopy time than the other two methods. Also the review concluded that RIRS offers a similar SFR to PCNL but a lower efficiency than PCNL (27).

In a study comparing micro-PNL and RIRS in kidney stones between 1-2 cm in children less than 3 years of age, SFR and complication rates were shown to be similar. In that study, a difference was found between the two groups in favour of micro-PCNL only in terms of the number of anaesthesia sessions needed (28). In another study involving 74 paediatric patients, RIRS was shown to be superior to PCNL in terms of blood creatinine level change; operation time, fluoroscopy time, complication rate, and hospital stay (29).

## CONCLUSION

RIRS is a minimally invasive treatment method in kidney stones that can be performed safely with high success rates in the paediatric age group within the appropriate indication.

**Conflict of interest**

No conflict of interest was declared by the authors.

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