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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

Comparison of Pediatric Retrograde Intrarenal Surgery Outcomes in Less than 2 cm Single Stones: Lower Pole and Other Localizations

İki cm'den Küçük Tek Taşlarda Pediatrik Retrograd İntrarenal Cerrahi Sonuçlarının Karşılaştırılması: Alt Kutup ve Diğer Lokalizasyonlar

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ÖZET

Amaç: Çalışmamızın amacı 2 cm'den küçük tek taşlarda alt pol lokalizasyonunun diğer lokalizasyonlara kıyasla pediatrik retrograd intrarenal cerrahi (RIRS) sonuçları üzerindeki etkisini araştırmaktır.

Gereç ve Yöntemler: Ocak 2021 ile Haziran 2024 arasında bir üniversite hastanesinde RIRS uygulanan hastaların verileri retrospektif olarak analiz edildi. Çalışmaya 2 cm'den küçük, tek taşı olan ve verilerine ulaşılabilen, 18 yaş altı 69 hasta dahil edildi. Hastalar böbrek taşı lokalizasyonuna göre iki gruba ayrıldı: alt pol (Grup 1) ve diğer lokalizasyonlar (Grup 2). Her iki grupta hastaların demografik verileri, klinik özellikleri, taşla ilgili verileri, perioperatif ve postoperatif verileri istatistiksel olarak karşılaştırıldı.

Bulgular: Çalışmaya ortalama yaşı 7±4.4 (1-17) yıl ve ortalama taş boyutu 11±3.3 (5-20) mm olan 69 hasta dahil edildi. Grup 1'de 21 hasta ve Grup 2'de 48 hasta vardı. Her iki gruptaki hastaların demografik verileri ve klinik özellikleri benzerdi. Grupların taş boyutu, lokalizasyonu ve dansitesi benzerdi (sırasıyla p=0.58, 0.58 ve 0.63). Grup 1'de prestenting oranı Grup 2'ye göre istatistiksel olarak anlamlı derecede daha yüksekti (%76.2 vs %50, p=0.04). Gruplar arasında access sheath kullanımı, operasyon süresi, floroskopi süresi, 1. gün ve 3. aydaki taşsızlık oranı veya ek prosedürler açısından istatistiksel olarak anlamlı bir fark saptanmadı (sırasıyla p=0.69, 0.95, 0.60, 0.97, 0.27 ve 0.28). Komplikasyon oranları her iki grupta benzerdi (p=0.28). Hastaların hiçbirinde yüksek dereceli veya anesteziyle ilişkili komplikasyon gözlenmedi.

Sonuç: Alt pol lokalizasyonu 2 cm'den küçük tek taşlarda prestenting oranı hariç cerrahi parametreleri etkilememektedir. Pediatrik popülasyonda prestenting uygulamasının genel anestezi altında yapıldığı göz önüne alındığında, alt pol taşları anestezi seanslarının sayısını, radyasyon maruziyetini ve hastane yatışlarını artırabilir.

Anahtar Kelimeler: Alt pol, böbrek taşları, pediatrik RIRS, RIRS sonuçları

ABSTRACT

Objective: Our study aimed to investigate the effect of lower pole localization in solitary stones smaller than 2 cm on pediatric retrograde intrarenal surgery (RIRS) outcomes compared to other localizations.

Materials and Methods: Data from patients who underwent RIRS in a university hospital between January 2021 and June 2024 were retrospectively analyzed. The study included 69 patients under 18 years of age with single stones less than 2 cm and whose data were available. Patients were divided into two groups according to kidney stone localization: lower pole (Group 1) and other localizations (Group 2). Demographic data, clinical characteristics, stone-related data, and perioperative and postoperative data of the patients were statistically compared in both groups.

Results: The study enrolled 69 patients with a mean age of 7±4.4 (1-17) years and a mean stone size of 11±3.3 (5-20) mm. There were 21 patients in Group 1 and 48 patients in Group 2. The patient's demographic data and clinical characteristics in both groups were similar. The groups' stone size, side, and density were similar (p=0.58, 0.58, and 0.63, respectively). The prestenting rate was statistically significantly higher in Group 1 than in Group 2 (76.2% vs 50%, p=0.04). No statistically significant difference was detected between the groups in access sheath use, operation time, fluoroscopy time, the stone-free rate on 1st day and 3rd month, or auxiliary procedures (p=0.69, 0.95, 0.60, 0.97, 0.27, and 0.28, respectively). The complication rates were similar in both groups (p=0.28). No high-grade or anesthesia-related complications were observed in any of the patients.

Conclusion: The lower pole localization does not affect surgical parameters, except for the prestenting rate, in single stones smaller than 2 cm. Considering that prestenting is performed under general anesthesia in the pediatric population, lower pole stones may increase the number of anesthesia sessions, radiation exposure, and hospitalizations.

Keywords: Lower Pole, renal stones, pediatric RIRS, RIRS outcomes

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INTRODUCTION

Pediatric stone disease is a significant health problem that is endemic in Turkey and has an increasing incidence worldwide (1). The main reasons for this increase are changes in dietary habits, increased carbohydrate consumption, and a sedentary lifestyle (2). The higher recurrence rates compared to the adult population highlight the determination of underlying metabolic problems, preventive measures, and complete stone removal as the most critical steps in management (3).

Extracorporeal shockwave lithotripsy (ESWL) remains a critically important noninvasive treatment option for treating pediatric kidney stones <2 cm (4). In case of ESWL failure or the presence of unfavorable factors for ESWL (narrow infundibulum, long calyx, hars stone), retrograde intrarenal surgery (RIRS) with a flexible ureterorenoscope stands out as a minimally invasive treatment option (4). Technological advances have led to the emergence of flexible ureterorenoscopes with narrower calibers, better image quality, and greater flexion-deflexion capacity, making RIRS more common in the pediatric population for <2 cm kidney stones (5).

RIRS is an endourological modality with a stone-free rate ranging from 60% to 100% and a 10% to 20% complication rate (6, 7). The most important factors affecting success are stone size, surgeon experience, multiple localizations, the harsh chemical structure of the stone, and differences in the anatomical structure of the calyces (8, 9). The debate over whether stone localization affects the outcomes is a current issue.

Lower pole localization may affect RIRS results because it reduces the deflexion capacity of the laser fiber and makes access to the stone difficult (10, 11). However, some data also show that localization doesn't change the results of RIRS in children. This might be because more new, flexible ureterorenoscopes with smaller diameters are being used (12). The current literature contains limited and contradictory data investigating the effect of stone localization on pediatric RIRS results. Our study aimed to investigate the effect of lower pole localization in solitary stones smaller than 2 cm on pediatric RIRS outcomes compared to other localizations.

MATERIALS and METHODS

Patients:

Data from patients who underwent RIRS in a university hospital between January 2021 and June 2024 were retrospectively analyzed. The study included 69 patients under 18 years of age with single stones less than 2 cm and whose data were available. Patients with multiple stones, urinary tract infections, and those who underwent other surgery simultaneously with RIRS were excluded from the study.

Patient's demographic data, clinical data (comorbidity, American Society of Anesthesiologists score, kidney or urinary tract anomaly, creatinine levels, hemoglobin levels), stone-related data (localization, size, side, density), perioperative data (prestenting, use of access sheath, operation time, fluoroscopy time), and postoperative data (postoperative stenting, stone-free rates on the postoperative first day and third months, hospital stay, need for auxiliary procedures, complications) were analyzed. Preoperative low-dose non-contrast computed tomography was used to evaluate the stone characteristics.

Patients were divided into two groups according to kidney stone localization: lower pole (Group 1) and other localizations (Group 2). The investigated parameters were compared statistically between both groups. Ethical approval was obtained before the study (No:2024/5148).

Surgical Procedure:

All procedures were performed by a single surgeon under general anesthesia in the lithotomy position. The surgery was started by placing the guide wire into the renal pelvis with a 4.5/6.5 Fr fiber ureterorenoscope under direct vision. The surgeon determined the decision for prestenting, use of access sheath, and postoperative stenting. In cases where access sheath was used, 9.5/11 Fr size was preferred.

The RIRS was performed with a 7.5 Fr flexible ureteroscope. Lithotripsy was performed with 270 nm holmium: YAG laser fiber at 0.5–1 Joule, 5–12 Hertz settings. A combination of fragmenting, dusting, and pop-dusting techniques was employed based on stone characteristics during each surgery. Repositioning with a basket did not perform any of the patients. The stone-free rate was evaluated by perioperative ureterorenoscopy and postoperative ultrasonography and was accepted as fragments <3 mm (13). Patients were followed up with ultrasound and kidney ureter bladder (KUB) graphy on the 1st postoperative day and with urinalysis, serum creatinine levels, and ultrasound at the 3rd month.

Statistical Analysis:

A statistical software package program was utilized for statistical analysis. Descriptive analysis was performed on the statistics of all numerical data with mean, standard deviation, minimum, and maximum values. Hospitalization time was expressed as the median value due to the standard deviation rate. Distribution was analyzed depending on normality using either the Student's T-test or Mann–Whitney U test. Categorical data were compared using Fisher's exact test. The Wilcoxon signed-rank test was used to compare the dependent samples. A mixed ANOVA test was used to compare the preoperative and postoperative creatinine and hemoglobin levels. A "p" value < 0.05 was accepted as statistically significant.

RESULTS

The study enrolled 69 patients with a mean age of 7±4.4 (1-17) years and a mean stone size of 11±3.3 (5-20) mm. There were 21 patients in Group 1 and 48 patients in Group 2. In Group 2, 12 (25%) patients had middle calyx stones, 7 (14.6%) patients had upper calyx stones, and 29 (60.4%) patients had renal pelvis stones.

Demographic and clinical characteristics of patients were similar in both groups (Table 1). No kidney or urinary tract anomaly was detected in Group 1. In Group 2, two patients had mild ureteropelvic junction obstruction, and one had horseshoe kidney (p=0.24). No statistically significant difference was detected within the groups' preoperative and postoperative hemoglobin and creatinine levels (p>0.05).

Table 1. Demographic and clinical characteristics of patients

	Group 1 (n=21)	Group 2 (n=48)	p
Age (years)	7.8±4.1 (3-16)	6.6±4.6 (1-17)	0.33
Gender (F/M)	12/9	23/25	0.55
Weight (kg)	28.1±12.2 (13-50)	24.8±11.8 (9-50)	0.30
Height (cm)	114±16 (94-142)	109±18 (74-145)	0.23
Comorbidity	1 ASD	1 VSD	0.32
ASA Score			
1	10	24	
2	10	23	0.92
3	1	1	
Kidney or urinary tract anomaly (n/%)	0 (0)	3 (6.3)	0.24
Preoperative creatinine (mg/dl)	0.5±0.1 (0.3-0.8)	0.5±0.2 (0.2-1.9)	0.70
Postoperative creatinine (mg/dl)	0.5±0.1 (0.2-0.8)	0.57±0.3 (0.2-1.9)	0.47
Preoperative hemoglobin (g/dl)	12.6±1.4 (10-14.9)	12.1±1.4 (9-15.9)	0.21
Postoperative hemoglobin (g/dl)	12.8±1.9 (10.2-16.1)	12.4±1.5 (9.4-15.8)	0.15

ASA: American Society of Anesthesiologists score, ASD: atrial septal defect VSD: ventricular septal defect

In addition, the mixed ANOVA test detected no statistically significant difference in creatinine (p=0.22) and hemoglobin (p=0.76) levels. The groups' stone size, side, and density were similar (p=0.58, 0.58, and 0.63, respectively). The prestenting rate was statistically significantly higher in Group 1 than in Group 2 (76.2% vs 50%, p=0.04). The access sheath use rate was similar (p=0.69, Table 2).

In Group 1, the mean operation time and fluoroscopy time were higher. However, this difference was not statistically significant (p=0.95 and p=0.60). Stone-free rate (SFR) on 1st day and 3rd month was lower in Group 1 than in Group 2 (81% vs 81.3%, 85.7% vs 93.8%). However, the difference was not vital to generate statistical significance (p=0.97 and 0.27). The rate of auxiliary procedures required to achieve the SFR in the 3rd month was 19% in Group 1 and 14.5% in Group 2 (p=0.28, Table 2).

Patients were discharged after a median of 2 (1-3) days of hospitalization. The total complication rate was 14.4%. Complication rates were similar between groups, and no high-grade complications were observed in any patient (p=0.28). In Group 1, two patients had grade 1 complications (stent discomfort), and one patient had grade 2 complications (urinary infection). In Group 2, five patients had grade 1 (three stent discomforts, two fevers), and two had grade 2 (urinary infection) complications (Table 2). No long-term complications (such as ureteral stenosis, vesicoureteral reflux, or recurrent urinary tract infection) were observed during the follow-up period.

Table 2. Perioperative and postoperative data of patients

	Group 1 (n=21)	Group 2 (n=48)	p
Stone size (mm)	11.3±3.5 (7-20)	10.8±3.3 (5-20)	0.58
Stone side (R/L)	12/9	24/24	0.58
Stone density (HU)	914±189 (500-1280)	951±327 (300-1677)	0.63
Prestenting (n/%)	16 (76.2)	24 (50)	0.04
Access sheath (n/%)	6 (28.6)	16 (33)	0.69
Operation time (min)	66.1±19 (30-95)	65.8±23.3 (25-140)	0.95
Fluoroscopy time (sec)	10.7±2.7 (7-15)	10.3±3.3 (6-25)	0.60
Postoperative stenting (n/%)	13 (61.9)	36 (75)	0.27
Stone-free rate on 1st day (n/%)	17 (81)	39 (81.3)	0.97
Stone-free rate on 3rd month (n/%)	18 (85.7)	45 (93.8)	0.27
Hospitalization time (day)	2±2.1 (1-10)	2.6±2.7 (1-15)	0.39
Auxiliary procedures			0.28
ESWL	1	3	
URS	1	2	
RIRS	2	4	
Complication (Clavien-Dindo grade)			0.36
1	2 (9.5)	5 (10.4)	
2	1 (4.7)	2 (4.1)	

ESWL: Extracorporeal Shock Wave Lithotripsy, HU: Hounsfield Unit, RIRS: Retrograde Intrarenal Surgery, URS: Ureterorenoscopy

DISCUSSION

The current study showed that lower pole localization increases the prestenting rate during RIRS of solitary pediatric kidney stones smaller than 2 cm. However, no difference was observed in other surgical parameters such as operative time, fluoroscopy time, stone-free rate, and complications. Since prestenting is performed under general anesthesia in the pediatric population, the possibility of requiring multiple sessions in the treatment of lower pole stones with flexible ureteroscopy and the possible clinical consequences of this should be considered.

Technological innovations in endourology have brought about major changes in the treatment of pediatric kidney stones. ESWL and RIRS have become the most preferred treatment methods for kidney stones smaller than 2 cm (14). ESWL is the first-line safe and effective treatment option for ≤2cm kidney stones (4). However, the need for repeated sessions for complete stone-free status increased general anesthesia and radiation exposure in pediatric patients. In cases such as increasing stone size, multiple localization, and the presence of unfavorable factors for ESWL, RIRS stands out as a minimally invasive treatment option. In addition, improved image quality, deflection capacity, and advances in laser technology make RIRS more popular in pediatric kidney stones ≤2 cm (5).

Pediatric RIRS requires reaching the renal pelvis, which has less capacity than adults, through a narrow ureter and performing lithotripsy using the maneuverability of the flexible ureterorenoscope in this limited area. There are different data in the literature regarding the factors affecting pediatric RIRS results for general reasons, such as the different technical features of flexible ureterorenoscopes, surgeon experience, and age differences of the patient population included in the studies. Lower pole localization is also a factor in solitary stones, and contradictory data exist about whether it affects the RIRS results (15).

Cannon et al. reported in their study that lower pole localization significantly reduced SFR, especially in larger than 15 mm, when RIRS was not as common as it is today (16). Similarly, in their study, including adult and pediatric patients, Özkent et al. reported that lower pole localization significantly reduced SFR (11). It has also been stated that lower pole localization reduces SFR in multiple large stones (17). The main reasons why lower pole localization affects SFR are unfavorable anatomy, narrow infundibulopelvic angle, and laser fiber decreasing the deflection capacity of the flexible ureterorenoscope (11, 18). However, on the contrary, essential data in the literature shows that lower pole localization does not affect SFR in pediatric RIRS.

A study using two different calibers of ureterorenoscopy stated that lower pole localization did not affect SFR (12). Kaygısız et al. reported that lower pole localization did not affect the SFR in single kidney stones smaller than 2 cm, similar to our data (19). Some studies have revealed a similar situation. Unsal et al. reported that localization did not affect the results of RIRS in their studies, which included infants and preschool-age children, and Azili et al. reported that localization did not affect the results of RIRS in their studies, which included mostly children with staghorn stones (20, 21). The most important focus of the studies indicating that stone localization does not affect SFR has been the increase in maneuverability of flexible ureterorenoscopes with technological developments (12).

We believe that the most important reasons stone localization did not affect RIRS outcomes except for prestenting in our study are improvement in image quality and increase in flexion-deflexion capacity with the developments in endourology. The study included up-to-date patient data, which led us to reach this opinion. Another reason may be that a single experienced surgeon operates on patients. The most important advantages of experience that will improve RIRS outcomes are developing tips and tricks and reflexive surgical skills (22). In this way, surgical gains that provide access to all localizations, including the lower pole, may contribute to RIRS results.

The ureter is narrower in caliber in pediatric patients than in adult patients, so retrograde access may be more difficult during RIRS. Balloon dilatation, hydrodilatation, and passive dilatation with a double J stent (prestenting) techniques can be used to overcome this difficulty (5, 23). Conflicting recommendations exist on which technique to use. However, concerns that it may increase the incidence of ureteral complications and vesicoureteral reflux have led us to move away from active balloon dilation. Approximately 58% of our patients underwent prestenting. This rate varies between 38% and 100% in the literature (8, 16, 20, 24).

The high rate of prestenting lower pole stones in our study may be due to two reasons. Lower pole localization complicates ESWL and reduces SFR (25). This may have led to the prioritization of RIRS to provide SFR in lower pole stones. Concerns about the low efficacy of ESWL may lead to a greater preference for prestenting to increase retrograde access to the kidney. Another reason for the higher prestenting rate in lower pole stones may be these patients' incidental narrower ureteral caliber. The fact that ureteral caliber was not measured in the patients included in the study makes it impossible to present objective data regarding this hypothesis.

Considering that double J stents are placed under general anesthesia in pediatric patients, the clinical consequences of higher prestenting rates in lower pole stones become important. Increased anesthesia complications and radiation exposure due to repeated sessions are situations that should be taken into consideration in lower pole stones. It has also been reported that recurrent urological surgeries increase parenteral anxiety levels (26). This may lead to treatment noncompliance and an increase in medicolegal problems. Parents of patients with lower pole stones should be adequately informed about the increased prestenting risk and cumulative general anesthesia risks.

When we evaluated our other findings, we found that lower pole localization statistically insignificantly increases operation time, fluoroscopy time, and auxiliary procedures, decreasing the SFR on the first day and third month. However, since more patients may make this difference statistically significant, caution is required in lower pole RIRS. The fact that complication rates in both groups were similar to those in the literature indicates that pediatric RIRS can be safely applied in all localizations (27).

Our study has several limitations. The retrospective design prevents the evaluation of the current RIRS criteria, such as removal, fragmentation, basketing, and operating rates. Another significant limitation is the lack of stone analysis data. However, the fact that stone densities were similar in both groups suggests that the chemical structure was also similar. Despite all these limitations, our study provides significant findings regarding the effects of stone localization on pediatric RIRS results. Our data should be supported with prospective randomized controlled studies.

CONCLUSION

Innovations in endourology, structural changes in flexible ureterorenoscopes, and increased surgical knowledge are increasing the popularity of pediatric RIRS. Although lower pole localization does not change SFR in single stones smaller than 2 cm, it is important because it affects factors such as prestenting rate, which will increase the number of anesthesia sessions, radiation exposure, and hospitalizations. The surgeons should inform the parents about this issue and plan the endourological procedure.

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