

## Pediatric Pyeloplasty in the Poor Function Kidneys: Does Surgical Success Guarantee Improvement in Renal Function? Single-Center Experience and Review of Literature

Farzaneh Sharifiaghdas<sup>1</sup>, Jalal Amini<sup>1</sup>, Behzad Narouie<sup>1,2\*</sup>, Hamidreza Rouieentan<sup>1</sup>, Mohadese Ahmadzade<sup>1</sup>,  
Mohammad Aref Emami<sup>3</sup>

**Purpose:** To investigate the effect of pyeloplasty in pediatric patients with poor function kidneys, focusing on the split renal function (SRF) and anteroposterior diameter (APD) of the renal pelvis.

**Materials and Methods:** A retrospective study included 47 pediatric patients with ureteropelvic junction obstruction (UPJO) who underwent open pyeloplasty with SRF < 20%. All patients were recruited from the Labbafinejad University Hospital center from April 2014 to October 2020. The results of preoperative ultrasonography and Diethylenetriamine pentaacetate (DTPA) scan compared with the results of the ultrasonography and DTPA scan 6 months and one year after surgery. Finally, Wilcoxon signed-rank test was used to test differences the SPSS (version 25) software statistical computer package.

**Results:** The mean age of participants was 1.5 years. There were 34 cases with SRF between 10% and 20%, and 13 cases with SRF < 10%. The findings showed that pyeloplasty for UPJO leads to a significant improvement in renal function in poorly functioning renal units with  $10\% \leq \text{SRF} < 20\%$ . Although improvement in renal function occurred in the group with SRF of less than 10%, it was not statistically significant. The APD in both groups was statistically significantly improved. No correlation between genders and outcomes was found.

**Conclusion:** Poorly functioning renal unit (SRF < 20%) can show functional improvement after the pyeloplasty.

**Keywords:** Ureteropelvic junction obstruction; split renal function; pyeloplasty; pediatrics; anteroposterior diameter

### INTRODUCTION

Ureteropelvic junction obstruction (UPJO) is one of the most common causes of symptomatic ureteral obstruction in the pediatric population. One-third of children with UPJO require surgical intervention.<sup>(1)</sup> The indications for surgery are breakthrough infection while on prophylactic antibiotics, low or decreasing differential renal function, or symptoms such as pain in older children and increasing anteroposterior diameter (APD) of the renal pelvis.<sup>(1-3)</sup>

In cases of persistent obstruction, the split function of the kidney may dramatically decrease, and consequently, surgical correction will be necessary.<sup>(3)</sup>

To perform surgery on UPJO, it is necessary to take into consideration a number of clinical factors, such as symptomatology, degree of hydronephrosis and cortical thinning on ultrasound, and reduction in differential function demonstrated by renal scintigraphy.<sup>(4)</sup> The intervention for poorly functioning kidneys has no clear protocol.<sup>(1)</sup> Nephrectomy is recommended in poorly functioning kidneys with split renal function (SRF) of less than 10% in some literature.<sup>(5,6)</sup>

Recently, some studies recommend pyeloplasty even with SRF < 10% and showed significant improvement in renal function postoperatively.<sup>(7-9)</sup> The present study

aimed to evaluate pyeloplasty outcomes in pediatric patients with ureteropelvic junction obstruction in renal units with poor split renal function and assess postoperative renal function recoverability.

### MATERIALS AND METHODS

#### Study Population

In this retrospective study, from 326 pediatric patients with UPJO who underwent open pyeloplasty by one surgeon (F.S) between April 2014 to October 2020, 49 pediatrics with split renal function less than 20% were selected. Two parents were reluctant to participate in this study. Ultimately, 47 pediatric patients were included in the study. Patients were divided into two groups based on their SRF values. Group A included patients with SRF values less than 10%, and group B included patients with SRF between 10 and 20% with 13 and 34 cases in each group, respectively.

The patients were treated with a retroperitoneal dismembered approach to pyeloplasty in the Department of Urology, Labbafinejad University Hospital over 7 years. All parents of the participants signed informed consent forms before the treatment. Patients with bilateral UPJO, contralateral damaged kidney, solitary or fused kidney, or other associated anomalies such as

<sup>1</sup>Urology and Nephrology Research Center, Department of Urology, Shahid Labbafinejad Medical Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

<sup>2</sup>Department of Urology, Zahedan University of Medical Sciences, Zahedan, Iran.

<sup>3</sup>Department of Surgery, Zahedan University of Medical Sciences, Zahedan, Iran.

\*Correspondence: Urology and Nephrology Research Center; Department of Urology, Shahid Labbafinejad Medical Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran. E mail: b\_narouie@yahoo.com.

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**Table 1.** Statistical results for pyeloplasty effect on preoperative vs postoperative SRF considering the cases gender

Cases	Gender	Preoperative SRF	6 months postoperative SRF	P-Value	One-year postoperative SRF	P-Value
Group A	male	5.5 (1-9)	10 (5.5-18.5)	0.073	11 (5.5-28.5)	0.066
	female	6.5 (1-9)	11 (5.5-18.5)	0.076	11.5 (5.5-19)	0.075
	total	6 (1-9)	11 (5.5-18.5)	0.073	11.5 (5.5-19)	0.068
Group B	male	13.5 (10-19)	29 (23.5-36.5)	< 0.001	32.5 (25.5-38.5)	< 0.001
	female	14.5 (10-19)	32 (23.5-36.5)	0.002	32 (25.5-38.5)	< 0.001
	total	14 (10-19)	31 (23.5-36.5)	< 0.001	32 (25.5-38.5)	< 0.001

SRF: split renal function. P-Value less than 0.05 is significant. All values are expressed as median (IQR).

posterior urethral valve and vesicoureteral reflux were excluded. Indications for pyeloplasty were associated symptoms, decline or impaired SRF, urinary tract infection and an obstructive pattern on initial renogram, and an increase in APD on serial ultrasonography (US). The initial diagnosis was made by assessment of US and Diethylenetriamine pentaacetate (DTPA) scan. The US was used to evaluate the APD of the renal pelvis before surgery and six months after pyeloplasty.<sup>(2,10-12)</sup> The parameters measured by diuretic renogram with <sup>99m</sup>Tc-DTPA included split renal function, half-time drainage, and wash-out diuretic curve. Additionally, voiding Cystourethrography was performed in all patients to exclude vesicoureteral reflux.<sup>(13)</sup> All participants underwent open Anderson-Hynes dismembered pyeloplasty through a retroperitoneal approach on the 12th rib. A double J (DJ) stent was placed during surgery.

Thereafter, anastomosis was made in a single layer using 5-0 Vicryl suture. The patients were discharged after three days from the hospital, and the double J was removed under intravenous sedation 4 weeks postoperatively. Postoperative results were evaluated by comparing pre and postoperative APD of the renal pelvis and split renal function six months and one year after surgery.

### Statistical Analysis

All values presented in this study are reported as median with interquartile range (IQR). Ultimately, Wilcoxon signed-rank test was used to test differences in APD and renogram before and after the intervention using SPSS (version 25) software statistical computer package.

## RESULTS

The study included 47 pediatric patients with UPJO who had SRF less than 20%. Twenty-one patients (45%) were female and 26 (55%) were male, with a median age of 1.5 years old (range, 6 months-10 years). UPJO was on the left and right sides in 28 (60%) and 19 (40%) patients, respectively. Of all the participants, 34 (72%) cases had 10% ≤ SRF < 20% (group B), and the remaining 13 cases had SRF < 10% (group A).

The median preoperative SRF was 6% (range: 1%-9%) in group A and 14% (range: 10%-20%) in group B. No intraoperative complications and blood loss was observed. The mean operative time was 69.4±15.8 min. All patients received intravenous anti-biotic injections. During the first 24 hours postoperatively, and in those afebrile cases it was replaced by oral antibiotics until discharge.

Of all the cases in the present study, five (11%) developed postoperative complications such as fever and

vomiting which were treated conservatively. Forty-two cases (89%) did not have any complications postoperatively. The patients were discharged from the hospital after three days. Complicated pediatric patients were discharged with a median hospital stay of five days. All patients remained on low-dose prophylactic antibiotics after 7 days.

Table 1 shows the difference between preoperative and postoperative SRF. As mentioned, significant statistical differences in SRF 6 months and one year after surgery were not observed in group A. However, in group B, there was a significant improvement ( $P < 0.001$ ). Statistical data also indicated that the median SRF after six months and one year was 11% and 11.5% for group A and 31% and 32% for group B, respectively. There was no significant difference between renogram studies at six months and one year for group A ( $P = 0.143$ ) and group B ( $P = 0.181$ ). The results demonstrated that there was no substantial improvement in the outcomes of pyeloplasty in both males and females in group A, both after 6 months and one year of intervention (Table 1). Hence, it can be inferred that gender does not play a significant role in determining the impact of pyeloplasty on SRF outcomes in patients.

The outcomes of pyeloplasty on preoperative and postoperative APD in relation to gender are presented in Table 2. The median preoperative APD of the renal pelvis was 2.9 cm (range: 2.2-5) for group A and 2.8 cm (range: 1.8-6) for group B. The median postoperative pelvic APD was 1.8 cm (range: 0.8-2.9) for cases in group A (P-value:0.069 and 0.086 for male and female respectively) and 0.9 cm (range: 0.5-1.9) for cases in group B ( $P$ -value < 0.001). The results demonstrated that the gender of the patients did not affect the overall findings of the impact of pyeloplasty on APD outcomes in group A. However, in group B, the statistical analysis indicates a significant improvement in APD outcomes after pyeloplasty ( $P < 0.001$ ).

## DISCUSSION

UPJO is defined as an obstruction to the flow of urine from the renal pelvis to the proximal ureter.<sup>(14,15)</sup> It causes flank pain, hematuria, urinary tract infection, and also renal function impairment.<sup>(16)</sup> pyeloplasty is a gold standard therapy for UPJO with a success rate of more than 95%.<sup>(17,18)</sup> The effects of pyeloplasty in children with poorly functioning kidneys are still appraised.<sup>(15)</sup> We evaluated the outcome of SRF in 47 children with preoperative SRF less than 10% (13 patients) and 10% ≤ SRF < 20% (34 patients) on diuretic renal scintigraphy after open pyeloplasty to detect renal function improvement. We evaluated the change in Split renal function after successful pyeloplasty in those kidneys

**Table 2.** Statistical results for pyeloplasty effect on preoperative vs postoperative APD considering the cases gender

Cases	Gender	Preoperative APD (cm)	postoperative APD (cm)	P-Value
Group A	male	2.70 (2.2-5)	1.75 (0.8-2.9)	0.069
	female	2.95 (2.3-5)	1.95 (0.8-2.9)	0.086
Group B	male	2.75(1.8-6)	0.95 (0.5-1.9)	< 0.001
	female	3.05 (1.8-6)	1.05 (0.5-1.9)	< 0.01

APD: anteroposterior diameter.

All values are expressed as median (IQR).

with preoperative poor functions (SRF less than or equal to 20%)

Salem et al.<sup>(19)</sup> retrospectively reviewed a series of 98 children with UPJO and analyzed them after pyeloplasty according to patient age. Renal function improved in one-third of each age group, while 77% had impaired function (40% or less). The kidney function did not improve with age. In the present study, the function of kidneys with  $10\% \leq \text{SRF} < 20\%$  improved, which was statistically significant. However, SRF did not improve in the kidneys with preoperative SRF of less than 10% despite surgical success.

Some studies have shown an improvement in SRF in poorly functioning kidneys after the insertion of a nephrostomy tube. In the study of Gupta et al.<sup>(20)</sup> percutaneous nephrostomy (PCN) tube was used preoperatively in patients with UPJO and SRF of less than 10%. 12 of 17 renal units with UPJO improved after PCN drainage and underwent pyeloplasty. The SRF value was  $31.4\% \pm 12.8\%$  after a follow-up of 2.3 years. PCN is not routinely performed in our center to avoid surgical site contamination as policy except for emergency cases of pyonephrosis and fever. In contrast, there was no improvement in renal function in group A of our cases. Methods for follow-up after UPJO surgery are controversial. Symptom resolution is only valid for symptomatic, older patients. To determine the success of surgery, ultrasonography, and renal scintigraphy are often used. Renal scintigraphy measures tracer uptake and excretion quite accurately. Scintigraphy often shows residual obstruction after surgery, complicating the determination of whether surgery failed or simply the effects of the surgical procedure.<sup>(21)</sup> Scintigraphy is also expensive, time-consuming, and not readily available, making it an unsuitable modality for regular follow-up. Despite the convenience of US. in following up, debate persists regarding what parameters and values matter most. Generally, the APD and the CT are used as measurements, while others including Pelvic Cortical Ratio and Calyx to Parenchymal Ratio (CPR) are proposed. The interpretation of these values, however, is not straightforward.<sup>(22)</sup> Few studies have investigated the effect of pyeloplasty on APD in poorly functioning kidneys. In our study, we found that the APD in both groups was significantly improved after pyeloplasty in kidneys with  $\text{SRF} < 20\%$  without any pelvic reduction. Although, the gender of cases does not affect the overall findings of pyeloplasty outcome on APD. Abdelaziz et al.<sup>(2)</sup> found a significant decrease in the anteroposterior diameter of the pelvis 6 months and one-year post-operation in kidneys with a split renal function of less than 10%. Minor pelvic reduction was performed in all cases intraoperatively to alleviate the effect of the major reduction on postoperative APD measurements.

Stock et al.<sup>(23)</sup> evaluated the association between renal function and histological renal changes after pediatric

pyeloplasty. They detected patients with UPJO, with a differential function of less than 35% have a high probability of significant histological changes on biopsy and a low probability of postoperative improvement in differential function. This contradicts our findings in the present study that renal function in group B improved markedly after pyeloplasty.

In the present study, the results of pyeloplasty in kidneys with  $\text{SRF} < 10\%$  were statistically different from some studies. Wagner et al.<sup>(3)</sup> reported pyeloplasty outcomes in 32 patients by dividing them into three groups (I > 40%, II 10-40%, III < 10%). In all patients, postoperative MAG3-diuretic nephrography demonstrated a significant improvement in SRF from 41%, preoperatively (range, 0-64%) to 47%, on average, postoperatively (range, 17-60%).

Lone et al.<sup>(7)</sup> included 24 pyeloplasty cases with  $\text{SRF} \leq 15\%$ . The postoperative SRF improved during 3 months follow-up with no significant changes at 9 months and 18 months results, this showed that the maximum improvement occurs early after relief of

obstruction and then tends to stabilize. Also in our study, we had a similar result in 6- and 12-months follow-up. Lone et al. also recommended that PCN should be installed only in acute emergencies, which is similar to the policy of our center. On the other hand, they concluded that even kidney function with SRF below 10% improved significantly which is in contrast with the results of this sub-group in our study.

Menon et al.<sup>(8)</sup> conducted a prospective evaluation of 102 patients with UPJO and  $\text{SRF} < 20\%$ . They divided patients into groups with SRF of 0-9% and groups with SRF of 10-20%. The study showed a significant increase in SRF from  $3.16 \pm 2.87$  to  $18.46 \pm 14.17\%$  in the SRF 0-9% group. The results have also shown increasing from  $14.84 \pm 3.39$  to  $23.71 \pm 10.48\%$  in the SRF 10%-20% group. The results presented in our study are nearly similar to this result for participants in group B but there was no significant increase in SRF in another group with  $\text{SRF} < 10\%$ .

In this study, we evaluated preoperative and postoperative median pelvic anteroposterior diameter in both groups. We found that median APD decreased significantly after pyeloplasty. This has been explored less in other studies.<sup>(2)</sup>

In a prospective study, Abdelaziz et al.<sup>(2)</sup> included 25 pediatric patients with unilateral UPJO and  $\text{SRF} \leq 10\%$ . The median preoperative SRF of 5% increased to 21% and 20% after six months and one year, respectively. Although in our study, The SRF in group A increased postoperatively, it was not statistically significant. They observed that meaningful improvement in SRF was higher in cases presented with a palpable mass, the median increased from 2% to 21%, which is nearly similar to our study, especially for the results of group B.

In the present study, the median for postoperative APD decreased in both groups, especially in group B. The gender of cases did not affect the overall findings of APD after pyeloplasty. Also, the gender of participants had no significant role in pyeloplasty. This correlates well with the findings of Wagner et al.<sup>(3)</sup>.

None of the patients who developed postoperative complications or whose SRF did not improve after surgery did not undergo nephrectomy.

This study was subject to several constraints, notably a relatively short-term patient follow-up period and the retrospective study design, both of which could potentially impact the precision of our analysis. There is a possibility of regression to the mean as a consequence of our study design. Additionally, time trends unrelated to the intervention could confound our findings. Consequently, to mitigate these limitations and foster a more comprehensive understanding of the subject matter, it is advisable to undertake future research endeavors characterized by extended prospective follow-up durations. In addition, future studies can explore the utility of complementary metrics such as CPR or renal cortical thickness to provide a more thorough assessment of surgical outcomes.

## CONCLUSIONS

Our data confirm pyeloplasty instead of nephrectomy, in UPJO patients with poor renal function due to the improvement of renal function in the pediatric age group.

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## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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